Argonne National Laboratory-East

Site Environmental Report
for Calendar Year 2002

ANL-03/2

By N. W. Golchert and R. G. Kolzow

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The Office of ESH/QA Oversight

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ARGONNE NATIONAL LABORATORY-EAST
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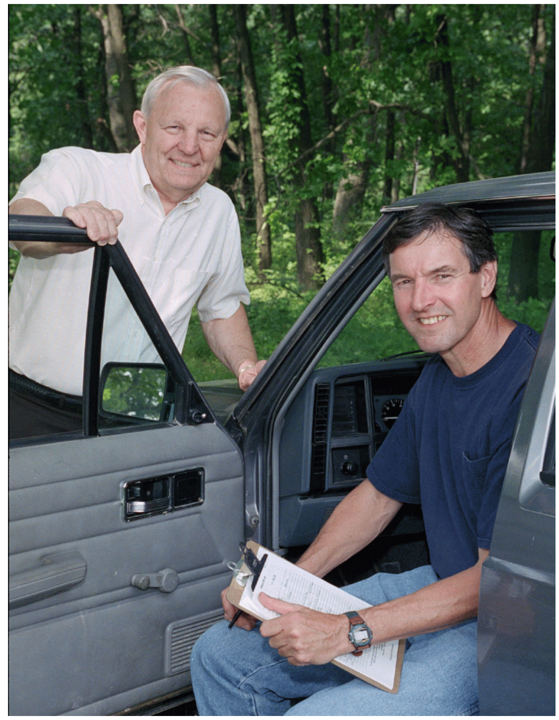

This Site Environmental Report (SER) was prepared by the Office of ESH/QA Oversight (EQO) at Argonne National Laboratory-East (ANL-E) for the U.S. Department of Energy (DOE). The results of the environmental monitoring program and an assessment of the impact of site operations on the environment and the public are presented in this publication. This SER and those for recent years are available on the Internet at http://www.anl.gov/ESH/ anleser/2002.

The majority of the figures and tables were prepared by Jennifer Tucker of the Data Management Team supported by Bob Utesch. Some figures, however, were prepared by Jim Kuiper of the Ecological and Geographical Sciences Section of ANL-E's Environmental Assessment Division. Sample collection and field measurements were conducted under the direction of Ronald Kolzow of the Environmental Monitoring and Surveillance Group by:

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ACM	Asbestos-Containing Material
AEA	Atomic Energy Act of 1954
ANL-E	Argonne National Laboratory-East
AOC	Area of Concern
APS	Advanced Photon Source
ATLAS	Argonne Tandem Linac Accelerating System
BAT	Best Available Technology
BCG	Biota Concentration Guide
BOD_5	Biochemical Oxygen Demand
CAA	Clean Air Act
CAAPP	Clean Air Act Permit Program
CAP-88	Clean Air Act Assessment Package-1988
CEDE	Committed Effective Dose Equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
CMT/ESH-AC	Chemical Engineering Division, ESH Analytical Chemistry
COD	Chemical Oxygen Demand
CP-5	Chicago Pile-Five
CRMP	Cultural Resources Management Plan
CWA	Clean Water Act
DCA	1,1-Dichloroethane
D&D	Decontamination and Decommissioning
DCG	Derived Concentration Guide
DMR	Discharge Monitoring Report
DOE	U.S. Department of Energy
DOE-AAO	U.S. Department of Energy, Argonne Area Office
DOE-EML-QAP	U.S. Department of Energy, Environmental Measurements Laboratory, Quality Assurance Program
DPCHD	DuPage County Health Department
E2	Energy Efficiency
EA	Environmental Assessment
EHS	Extremely Hazardous Substance
EIS	Environmental Impact Statement
EMS	Environmental Protection Data Management System
ENE	East-Northeast
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right to Know Act
EQO	The Office of ESH/QA Oversight

ACRONYMS

ERP	Environmental Remediation Program
ESA	Endangered Species Act
ESH	Environment, Safety and Health
FFCA	Federal Facility Compliance Act
FY	Fiscal Year
HAP	Hazardous Air Pollutant
HCFC-22	Chlorodifluoromethane
HSWA	Hazardous and Solid Waste Amendments
IAC	*Illinois Administrative Code*
ICRP	International Commission on Radiological Protection
IDNS	Illinois Department of Nuclear Safety
IDPH	Illinois Department of Public Health
IEPA	Illinois Environmental Protection Agency
IHPA	Illinois Historic Preservation Agency
IPNS	Intense Pulsed Neutron Source
ISM	Integrated Safety Management
LC_{50}	Median Lethal Concentration
LEED	Leadership in Energy and Environmental Design
LEPC	Local Emergency Planning Committee
LLW	Low-Level Radioactive Waste
LWTP	Laboratory Wastewater Treatment Plant
MACT	Maximum Achievable Control Technology
MSDS	Material Safety Data Sheet
MY	Model Year
NBL	New Brunswick Laboratory
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NFA	No Further Action
NHPA	National Historic Preservation Act
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NRHP	*National Register of Historic Places*
O&M	Operation and Maintenance
PA	Preliminary Assessment
P2	Pollution Prevention

PCB	Polychlorinated Biphenyl
PFS	Plant Facilities and Services
PPOA	Pollution Prevention Opportunity Assessment
PQL	Practical Quantification Limit
PSTP	Proposed Site Treatment Plan
PWA	Process Waste Assessment
QA	Quality Assurance
R&D	Research and Development
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SER	Site Environmental Report
SIP	Site Implementation Plan
SOP	Standard Operating Procedure
SPCC	Spill Prevention Control and Countermeasures
SSI	Site Screening Investigation
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
SWPPP	Storm Water Pollution Prevention Plan
SWPPC	Storm Water Pollution Prevention Committee
SWTP	Sanitary Wastewater Treatment Plant
TCA	1,1,1-Trichloroethane
TDS	Total Dissolved Solids
TLD	Thermoluminescent Dosimeter
TOC	Total Organic Carbon
TOX	Total Organic Halogen
TRI	Toxic Release Inventory
TRU	Transuranic Waste
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WMO	Waste Management Operations
WQS	Water Quality Standard
WTP	Wastewater Treatment Plant

ACRONYMS

This report discusses the accomplishments of the environmental protection program at Argonne National Laboratory-East (ANL-E) for calendar year 2002. The status of ANL-E environmental protection activities with respect to the various laws and regulations that govern waste handling and disposal is discussed, along with the progress of environmental corrective actions and restoration projects. To evaluate the effects of ANL-E operations on the environment, samples of environmental media collected on the site, at the site boundary, and off the ANL-E site were analyzed and compared with applicable guidelines and standards. A variety of radionuclides were measured in air, surface water, on-site groundwater, and bottom sediment samples. In addition, chemical constituents in surface water, groundwater, and ANL-E effluent water were analyzed. External penetrating radiation doses were measured, and the potential for radiation exposure to off-site population groups was estimated. Results are interpreted in terms of the origin of the radioactive and chemical substances (i.e., natural, fallout, ANL-E, and other) and are compared with applicable environmental quality standards. A U.S. Department of Energy dose calculation methodology, based on International Commission on Radiological Protection recommendations and the U.S. Environmental Protection Agency's CAP-88 (Clean Air Act Assessment Package-1988) computer code, was used in preparing this report.

This report summarizes the ongoing environmental protection program conducted by Argonne National Laboratory-East (ANL-E) in calendar year 2002. It includes descriptions of the site, ANL-E missions and programs, the status of compliance with environmental regulations, environmental protection and restoration activities, and the environmental surveillance program. The surveillance program conducts regular monitoring for radiation, radioactive materials, and nonradiological constituents on the ANL-E site and in the surrounding region. These activities document compliance with appropriate standards and permit limits, identify trends, provide information to the public, and contribute to a better understanding of ANL-E's impact on the environment. The surveillance program supports the ANL-E policy of protecting the public, employees, and the environment from harm that could be caused by ANL-E activities, and of reducing environmental impacts to the greatest degree practicable.

In 2002, ANL-E continued to implement its plan to complete all remedial actions at the site by the end of 2003. The plan is described in a document titled *Environmental Restoration Program (EM-40) Baseline for Argonne National Laboratory-East,* which was completed in early 1999.

Compliance Summary

Radionuclide emissions, the management of asbestos, and conventional air pollutants from ANL-E facilities are regulated under the Clean Air Act (CAA). A number of airborne radiological emission points at ANL-E are subject to National Emission Standards for Hazardous Air Pollutants (NESHAPs) regulations for radionuclide releases from U.S. Department of Energy (DOE) facilities (*Code of Federal Regulations*, Title 40, Part 61, Subpart H [40 CFR Part 61, Subpart H]). All such air emission sources were evaluated to ensure that these requirements are being addressed properly. The estimated hypothetical individual off-site dose from ANL-E activities required to be reported by U.S. Environmental Protection Agency (EPA) regulations in 2002 was 0.039 mrem/yr. This is 0.4% of the 10 mrem/yr standard. This dose does not include contributions from radon-220 and radon-222 emissions, as exempted in the regulations.

At ANL-E, asbestos-containing material (ACM) frequently is encountered during maintenance or renovation of existing facilities and equipment. Asbestos is removed and disposed of in strict accordance with NESHAPs and Occupational Safety and Health Administration worker protection standards. Approximately 79 m^3 (2,800 ft^3) of ACM was removed and disposed of at off-site landfills in Illinois during 2002.

The ANL-E site contains several sources of conventional air pollutants. The steam plant and fuel-dispensing facilities operate continuously and are the only significant sources of continuous air pollutants. The emergency generators at the Advanced Photon Source (APS) and the engine test facility are also significant sources, when operational. The Illinois Environmental Protection Agency (IEPA) issued the final ANL-E Clean Air Act Permit Program (CAAPP) Permit in April 2001. All previous air operating permits (with the exception of the open burning permits) were incorporated into this sitewide permit for all emissions sources and activities. The ANL-E CAAPP Title V Permit requires continuous opacity and sulfur dioxide monitoring of the steam plant smoke stack from Boiler No. 5, the only boiler equipped to burn coal. Low-sulfur coal was burned in Boiler No. 5 for four months during 2002. During the period coal was burned, which occurred during colder weather to supplement the other gas-fired boilers, no exceedances were observed.

The goals of the Clean Water Act are achieved primarily through the National Pollutant Discharge Elimination System (NPDES) permit program. The federal government has delegated implementation of the NPDES program to the State of Illinois. An application to renew the existing permit was submitted timely to the IEPA during December 1998. The IEPA did not act to review the permit renewal application in 2002, and, therefore, as provided for in the IEPA regulations, ANL-E continues to operate under its 1994 permit, as modified, until a renewal permit is issued. During 2002, six exceedances of the NPDES permit limits were reported out of approximately 1,600 measurements.

ANL-E was granted interim status under the Resource Conservation and Recovery Act (RCRA) upon submitting a Part A Permit application in 1980. The IEPA issued a RCRA Part B Permit on September 30, 1997, which became effective on November 4, 1997. The permit addresses 25 hazardous waste treatment and storage facilities and establishes corrective action procedures and requirements for 49 Solid Waste Management Units (SWMUs) and 3 Areas of Concern (AOCs). Since the issuance of the permit, three additional AOCs have been added to the permit. Following ANL-E remedial actions, the IEPA approved No Further Action requests for 38 SWMUs by the end of 2002. Eight units had all planned remedial actions completed and are in long-term operations and maintenance mode.

ANL-E has prepared and implemented a sitewide underground storage tank (UST) compliance plan. The ANL-E site contains 17 USTs, which are in compliance with UST regulations.

The only TSCA-regulated compounds in significant quantities at ANL-E are polychlorinated biphenyls (PCBs) contained in electrical capacitors, power supplies, and small transformers. The ANL-E PCB Item Inventory Program was initiated in 1995 to identify all suspect PCB-containing items. All pole-mounted transformers and circuit breakers containing PCBs have been replaced or retrofilled with non-PCB oil. All removal and disposal activities were conducted by licensed contractors specializing in such operations. During 2002, no radioactive PCB-contaminated articles, sludge, or debris were shipped off site for disposal, leaving 314 L (82 gal) in storage.

In 2002, most projects requiring National Environmental Policy Act (NEPA) review for assessment were determined to be categorical exclusions. One Environmental Assessment was initiated in 2002 for the enhanced operations at the APS, including the conduct of Biosafety Level-3 research and construction and operation of a Center for Nanoscale Materials and a Structural Genomics Facility.

The ANL-E Environment, Safety and Health and Infrastructure Management Plan identifies funding needs for on-site rehabilitation projects, environmental restoration projects, and waste management activities. The rehabilitation projects include identification of existing treatment facilities requiring upgrading or replacement. ANL-E environmental restoration activities consist of projects that assess and clean up inactive waste sites. These include two inactive landfills, three French drains (i.e., dry wells used to dispose of liquid chemicals), two inactive wastewater treatment facilities, and a number of areas that may have been contaminated with small amounts of hazardous chemicals. This work is funded by the DOE Office of Environmental Management and conducted at ANL-E by the Environmental Remediation Program.

Ongoing compliance issues at ANL-E during 2002 were effluent concentrations of total dissolved solids (TDS) in excess of NPDES Permit effluent limits; elevated levels of some routine indicator parameters in the groundwater at the former sanitary landfill; and cleanup of environmental contamination caused by previous activities on the ANL-E site.

Environmental Surveillance Program

Airborne emissions of radioactive materials from ANL-E were monitored during 2002. The effective dose equivalents were estimated at the site perimeter and to a hypothetical maximally exposed member of the public, with the EPA's CAP-88 (CAA Assessment Package-1988) computer code. The estimated maximum perimeter dose from airborne releases was 0.38 mrem/yr in the east direction, while the estimated maximum dose to a member of the public was 0.039 mrem/yr. This latter value is 0.04% of the DOE radiation protection standard of 100 mrem/yr for all pathways. If the contribution of radon-220 is excluded from reporting, as required by 40 CFR Part 61, Subpart H, the estimated dose to a maximally exposed member of the public would remain 0.039 mrem/yr. The estimated population dose from releases to the approximately nine million people living within 80 km (50 mi) of the site was 2.80 person-rem.

Monitoring of particulates in ambient air was conducted for total alpha activity, total beta activity, strontium-90, isotopic thorium, isotopic uranium, and plutonium-239 at the ANL-E site perimeter and at off-site locations. No statistically significant difference was identified between samples collected at the ANL-E perimeter and samples collected off site. Monitoring was not conducted for hazardous chemical constituents in ambient air.

The only detectable radionuclides and chemical pollutants in surface water due to ANL-E releases were in Sawmill Creek, below the wastewater discharge point. At various times, measurable levels of hydrogen-3, strontium-90, plutonium-239, and americium-241 were detected. Of these radionuclides, the maximum annual release was 0.10 Ci of hydrogen-3. The other radionuclides were released at less than 0.001 Ci total. The hydrogen-3 was added to the wastewater as part of normal ANL-E operations. The dose to a hypothetical individual using water from Sawmill Creek as his or her sole source of drinking water would be 0.016 mrem/yr. However, no one uses this water for drinking, and dilution by the Des Plaines River reduces the concentrations of the measured radionuclides to levels below their respective detection limits downstream from ANL-E at Lemont. Sawmill Creek also is monitored for nonradiological constituents to demonstrate compliance with State of Illinois water quality standards. Iron and copper occasionally were detected above the standards.

Sediment samples were collected from Sawmill Creek, above, at, and below the point of wastewater treatment plant effluent discharge. Elevated levels of plutonium-239 (up to 0.022 pCi/g) and americium-241 (up to 0.004 pCi/g) were detected in the sediment below the outfall and are attributed to past ANL-E releases.

Dose rates from penetrating radiation (gamma-rays) were measured at 17 perimeter and on-site locations and at 5 off-site locations in 2002 using thermoluminescent dosimeters. The off-site results averaged 93 ± 4 mrem/yr, which is consistent with the long-term average. Above-background doses occurred at one perimeter location and were due to ANL-E operations. At the south fence, radiation from a temporary storage facility for radioactive waste resulted in an average dose of 111 ± 11 mrem/yr for 2002, although no one occupies this area. The estimated dose from penetrating radiation to the nearest resident south of the site was less than 0.01 mrem/yr.

The potential radiation doses to members of the public from all sources and pathways due to ANL-E operations during 2002 were estimated by combining the exposure from inhalation, ingestion, and direct radiation pathways. The inhalation pathway dominates. The highest estimated dose was approximately 0.065 mrem/yr to a hypothetical individual living east of the site, assuming he or she was outdoors at that location during the entire year and drinking Sawmill Creek water. Estimated doses from other pathways were small by comparison. The doses from ANL-E operations are well within all applicable standards and are insignificant when compared with doses received by the public from natural radiation (≈300 mrem/yr) or other sources, for example, medical x-rays and consumer products (≈60 mrem/yr).

Radiological and chemical constituents in the groundwater were monitored in several areas of the ANL-E site in 2002. The former ANL-E domestic water supply is monitored by collecting quarterly samples from the three inactive supply wells. All results from water supply wells were less than the limits established by the Safe Drinking Water Act.

Ten monitoring wells screened in the glacial drift and two in the dolomite were sampled quarterly at the 317 and 319 Areas and analyzed for radiological, volatile organic, semivolatile, PCB, and pesticide and herbicide constituents. The major organic contaminants detected were trichloroethene, 1,1,1-trichloroethane, and 1,1-dichloroethane. Measurable levels of hydrogen-3 and strontium-90 were present in several of the wells. Remediation continued in this area using phytoremediation and groundwater extraction to remove volatile organic compounds (VOCs) and hydrogen-3 from groundwater.

Three monitoring wells are screened in the glacial drift and one in the dolomite adjacent to the Chicago Pile-Five reactor. These wells were sampled quarterly, and samples were analyzed for selected radionuclides, metals, VOCs, semivolatile organic compounds (SVOCs), pesticides, herbicides, and PCBs. Measurable levels of hydrogen-3 and strontium-90 were detected regularly. Low levels of dichlorofluoromethane were detected, in addition to a few inorganic constituents. All concentrations were well below any standard.

Twenty-six monitoring wells at the 800 Area Landfill were sampled on a quarterly basis and analyzed for metals, cyanide, phenols, total organic carbon, total organic halogens, VOCs, SVOCs, PCBs, pesticides, herbicides, and hydrogen-3. As in previous years, levels above Illinois Class I Groundwater Quality Standards for chloride, chromium, iron, lead, manganese, nickel, sulfate, and TDS were found in some wells. Above-background levels of hydrogen-3 were detected in several of the wells, with concentrations up to 427 pCi/L. This is well below the standard of 20,000 pCi/L.

An extensive quality assurance program is maintained to cover all aspects of the environmental surveillance sampling and analysis programs. Approved documents are in place, along with supporting standard operating procedures. Newly collected data were compared with recent results and historical data to ensure that deviations from previous conditions were identified and evaluated promptly. Samples at all locations were collected using well-established and documented procedures to ensure consistency. Samples were analyzed by documented standard analytical procedures. Data quality was verified by a continuing program of analytical laboratory quality control, participation in interlaboratory cross-checks, and replicate sampling and analysis. Data were managed and tracked by a dedicated computerized data management system that assigns unique sample numbers, schedules collection and analysis, checks status, and prepares tables and information for the annual report.

ANL-E maintains a documented environmental management system that identifies responsibilities for environmental activities. ANL-E is committed to implementing that system as part of the overall Integrated Safety Management System.

1. INTRODUCTION

1.1. General

This annual report for calendar year 2002 of the Argonne National Laboratory-East (ANL-E) environmental protection program was prepared to inform the U.S. Department of Energy (DOE), environmental agencies, and the public about the levels of radioactive and chemical pollutants in the vicinity of ANL-E, and the amounts, if any, added to the environment by ANL-E operations. It also summarizes the compliance of ANL-E operations with applicable environmental laws and regulations and highlights significant accomplishments and issues related to environmental protection and environmental remediation. The report was prepared in accordance with the guidelines of DOE Orders 5400.1[1] and 231.1[2] and supplemental DOE guidance.

ANL-E conducts an environmental surveillance program on and near the site to determine the identity, magnitude, and origin of radioactive and chemical substances in the environment. The detection of any releases of such materials to the environment from ANL-E operations is of special interest, because one important function of this program is verification of the adequacy of the site's pollution control systems.

ANL-E is a DOE research and development (R&D) laboratory with several principal objectives. It conducts a broad program of research in the basic energy and related sciences (i.e., physical, chemical, material, computer, nuclear, biomedical, and environmental) and serves as an important engineering center for the study of nuclear and nonnuclear energy sources. Energy-related research projects conducted during 2002 included safety studies for light-water reactors; high-temperature superconductivity experiments; development of electrochemical energy sources, including fuel cells and batteries for vehicles and for energy storage; evaluation of heat exchangers for the recovery of waste heat from engines; and studies to promote clean, efficient transportation.

Other areas of research are basic biological research, heavy-ion research into the properties of super-heavy elements, fundamental coal chemistry studies, the immobilization of radioactive waste products for safe disposal, fundamental studies of advanced computers, and the development of "chips" for the rapid assay of gene composition. Environmental research studies include the biological activity of energy-related mutagens and carcinogens, characterization and monitoring of energy-related pollutants, and new technologies for cleaning up environmental contaminants. A significant number of these laboratory studies requires the controlled use of radioactive and chemically toxic substances.

The principal radiological facilities at ANL-E are the Advanced Photon Source (APS); a superconducting heavy-ion linear accelerator (Argonne Tandem Linac Accelerating System [ATLAS]); a 22-MeV pulsed electron linac; several other charged-particle accelerators (principally of the Van de Graaff and Dynamitron types); a large fast neutron source (Intense Pulsed Neutron Source [IPNS]) in which high-energy protons strike a uranium target to produce neutrons; chemical and metallurgical laboratories; and several hot cells and laboratories designed for work with multicurie quantities of the actinide elements and with irradiated reactor fuel materials. The DOE New Brunswick Laboratory (NBL), a plutonium and uranium measurements and analytical chemistry laboratory, is located on the ANL-E site.

The principal nonnuclear activities at ANL-E in 2002 that could have measurable impacts on the environment include the use of a coal-fired boiler (No. 5), discharge of wastewater from various sources, and the cleanup of inactive waste disposal areas.

1.2. Description of Site

ANL-E occupies the central 607 ha (1,500 acres) of a 1,514-ha (3,740-acre) tract in DuPage County. The site is 43 km (27 mi) southwest of downtown Chicago and 39 km (24 mi) west of Lake Michigan. It is north of the Des Plaines River Valley, south of Interstate Highway 55 (I-55), and west of Illinois Highway 83. Figures 1.1 and 1.2 are maps of the site, the surrounding area, and sampling locations of the monitoring program. Much of the 907-ha (2,240-acre) Waterfall Glen Forest Preserve surrounding the site was part of the ANL-E site before it was deeded to the DuPage County Forest Preserve District in 1973 for use as a public recreational area, nature preserve, and demonstration forest. In this report, facilities are identified by the alphanumeric designations in Figure 1.1 to facilitate their location.

The terrain of ANL-E is gently rolling, partially wooded, former prairie and farmland. The grounds contain a number of small ponds and streams. The principal stream is Sawmill Creek, which runs through the site in a southerly direction and enters the Des Plaines River about 2.1 km (1.3 mi) southeast of the center of the site. The land is drained primarily by Sawmill Creek, although the extreme southern portion drains directly into the Des Plaines River, which flows along the southern boundary of the forest preserve. This river flows southwest until it joins the Kankakee River about 48 km (30 mi) southwest of ANL-E to form the Illinois River.

The largest topographical feature of the area is the Des Plaines River valley, which is about 1.6 km (1 mi) wide. This valley contains the river, the Chicago Sanitary and Ship Canal, and the Illinois and Michigan Canal. The elevation of the channel surface of these waterways is 180 m (578 ft) above sea level. The bluffs that form the southern border of the site rise from the river channel at slope angles of 15 to 60° and reach an average elevation of 200 m (650 ft) above sea level at the top. The land then slopes gradually upward and reaches the average site elevation of 220 m (725 ft) above sea level at 915 m (3,000 ft) from the bluffs. Several large ravines oriented in a north-south direction are located in the southern portion of the site. The bluffs and ravines generally are forested with mature deciduous trees. The remaining portion of the site changes in elevation by no more than 7.6 m (25 ft) in a horizontal distance of 150 m (500 ft).

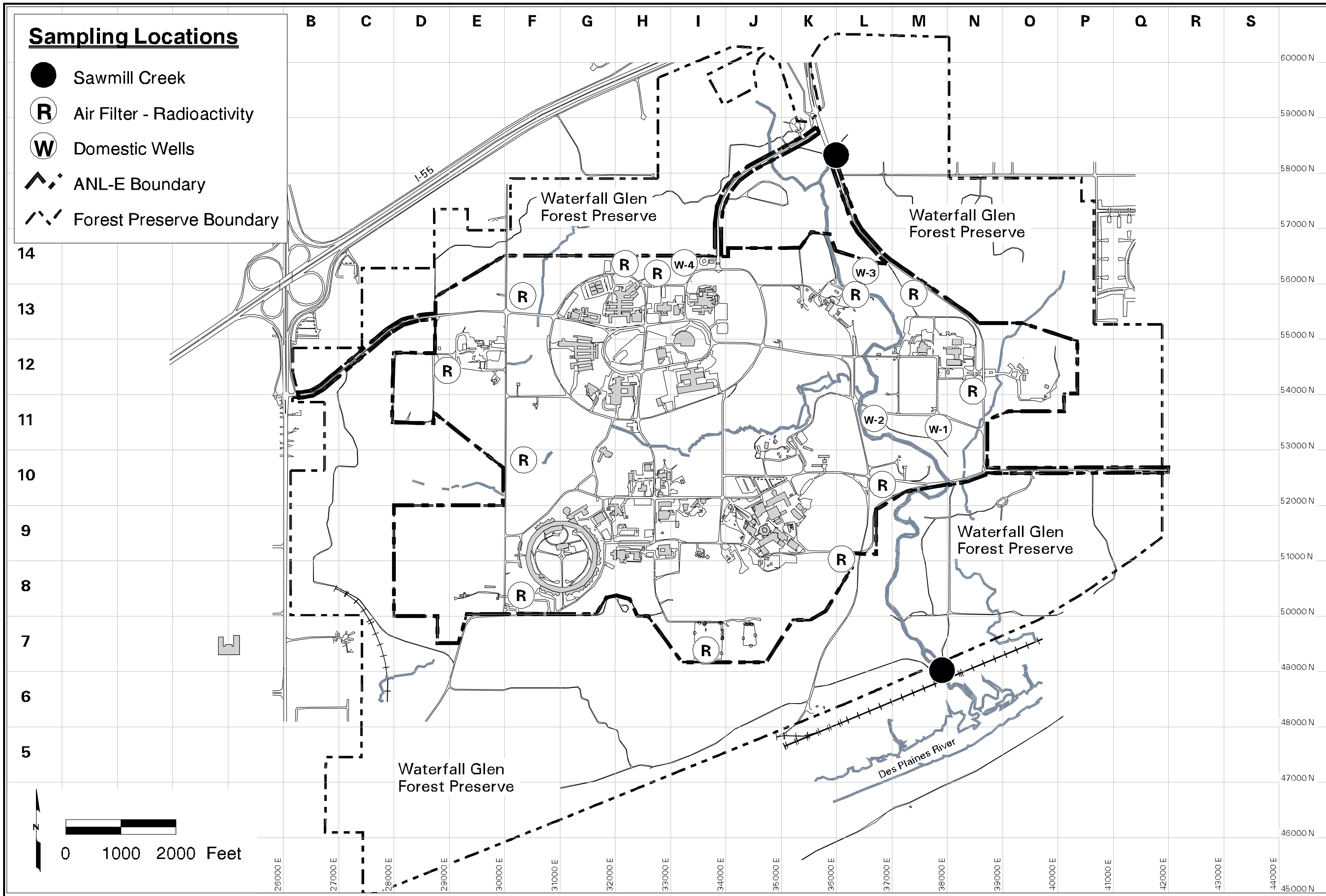


Figure 1.1 Sampling Locations at Argonne National Laboratory-East

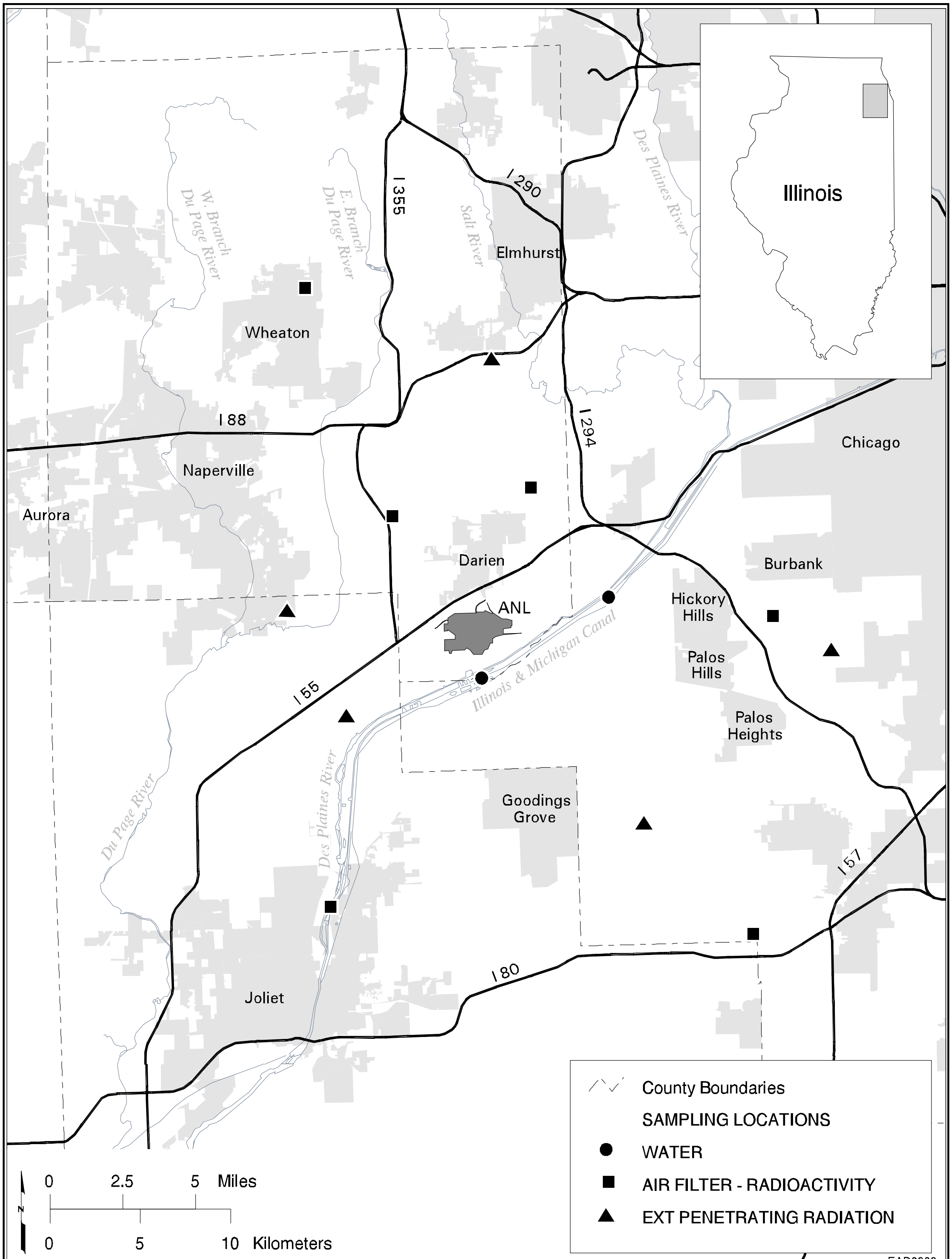


Figure 1.2 Sampling Locations near Argonne National Laboratory-East

1.3. Population

The area around ANL-E has experienced a large population growth in the past 30 years. Large areas of farmland have been converted into housing. Table 1.1 gives the directional and annular 80-km (50-mi) population distribution for the area, which is used to derive the population dose calculations presented later in this report. The population distribution, centered on the Chicago Pile-Five (CP-5) reactor (Location 9G in Figure 1.1), was prepared by the Risk Assessment and Safety Evaluation Group of the Environmental Assessment Division at ANL-E and represents projections on the basis of 2000 census data.

1.4. Climatology

The climate of the area is representative of the upper Mississippi Valley, as moderated by Lake Michigan. Summaries of the meteorological data collected on the site from 1950 to 1964 are available[3] and provide a historical sample of the climatic conditions. The most important meteorological parameters for the purposes of this report are wind direction, wind speed, temperature, and precipitation. The wind data are used to select air sampling locations and distances from sources and to calculate radiation doses from air emissions. Temperature and precipitation data are useful in interpreting some of the monitoring results. The 2002 data were obtained from the on-site ANL-E meteorological station. The 2002 average monthly and annual wind rose at the 60-m (200-ft) level is shown in Figure 1.3. The wind rose is a polar coordinate plot in which the lengths of the radii represent the percentage frequency of wind speeds in classes of 2.01 – 6 m/s (4.5 – 13.4 mph), 6.01 – 10 m/s (13.4 – 22.4 mph), and greater than 10.01 m/s (22.4 mph). The number in the center of the wind rose represents the percentage of observations of wind speed less than 2 m/s (4.5 mph) in all directions. The direction of the radii from the center represents the direction from which the wind blows. Sixteen radii are shown on each plot at 22.5° intervals; each radius represents the average wind speed for the direction covering 11.25° on either side of the radius. The annual average wind rose for 2002 is consistent with the long-term average wind direction, which usually varies from the west to south, but with a significant northeast component.

Table 1.2 gives 2002 precipitation and temperature data. The monthly precipitation data for 2002 show a few differences from the average. For example, April and May were above the monthly average, while February, July, September, and October were below the average. The annual total was 6% below the annual average for the ANL-E historic data and 10% below the O'Hare International Airport average. The temperatures were generally higher when compared with the long-term historical monthly average, but 22% higher than the long-term ANL-E monthly average. The climatology information was provided by the Atmospheric Research Section of the Environmental Research Division.

TABLE 1.1

Population Distribution in the Vicinity of ANL-E, 2000

	Miles[a]									
Direction	0 – 1	1 – 2	2 – 3	3 – 4	4 – 5	5 – 10	10 – 20	20 – 30	30 – 40	40 – 50
N	0	1,269	3,646	6,190	9,651	46,597	183,061	353,821	222,737	309,159
NNE	0	611	4,112	5,971	6,169	40,711	302,525	492,536	102,273	1,094
NE	0	837	2,010	2,138	1,846	42,637	712,685	1,009,469	0	0
ENE	0	1,021	1,291	2,308	1,986	33,931	633,468	195,890	0	0
E	0	1,163	557	366	386	42,520	467,488	216,642	9,770	26,128
ESE	0	590	269	371	509	18,494	190,441	293,764	230,611	91,154
SE	0	309	271	459	947	25,059	131,937	120,187	34,557	17,023
SSE	0	451	400	1,014	1,327	18,433	42,321	9,904	14,172	15,963
S	0	628	2,302	2,148	1,221	8,181	31,084	4,436	36,505	36,639
SSW	0	529	2,329	2,645	1,001	18,156	89,111	12,221	20,350	7,739
SW	0	213	596	409	142	14,931	66,453	12,394	17,310	7,385
WSW	0	168	159	554	2,628	17,249	23,864	5,422	8,705	11,633
W	0	186	2,026	7,735	9,338	40,270	93,303	23,547	17,727	6,810
WNW	0	528	1,862	5,815	6,516	46,444	154,113	37,805	7,469	58,587
NW	0	711	2,317	7,057	7,769	45,993	83,324	123,290	23,881	19,530
NNW	0	1,088	2,628	5,961	9,457	34,008	217,040	263,590	172,437	122,112
Total	0	10,302	26,775	51,141	60,893	493,614	3,422,218	3,174,918	918,504	730,956
Cumulative total[b]	0	10,302	37,077	88,218	149,111	642,725	4,064,943	7,239,861	8,158,365	8,889,321

[a] To convert from miles to kilometers, multiply by 1.6.

[b] Cumulative total = the total of this sector plus the totals of all previous sectors.

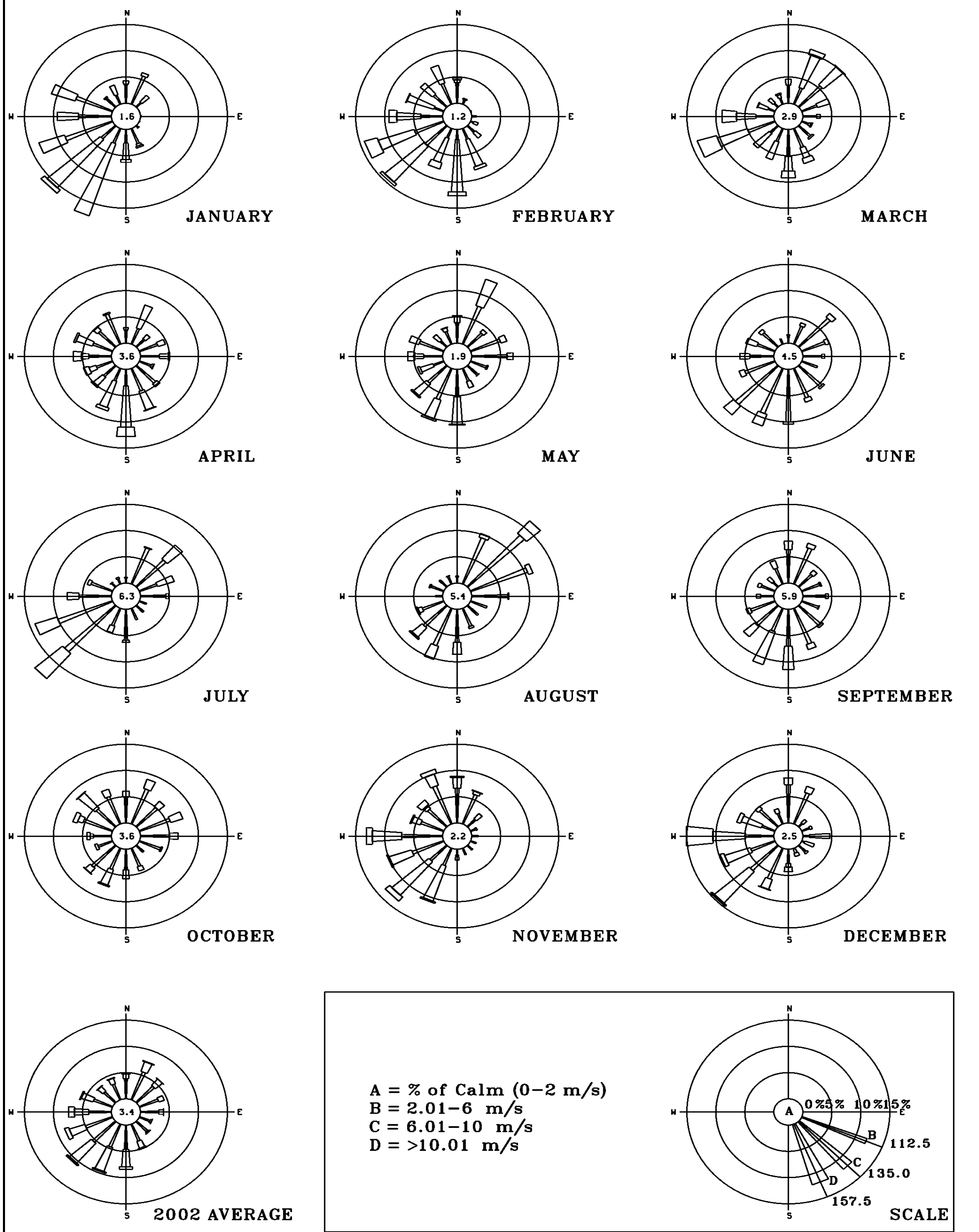


Figure 1.3 Monthly and Annual Wind Roses at Argonne National Laboratory-East, 2002

TABLE 1.2

ANL-E Weather Summary, 2002

	Precipitation (cm)				Temperature (°C)		
Month	ANL-E 2002	ANL-E Historical[a]	Historical[b]		ANL-E 2002	ANL-E Historical[a]	Historical[b]
January	3.78	3.61	4.06		– 0.4	– 5.9	– 5.9
February	2.34	3.38	3.33		– 0.2	– 3.7	– 3.3
March	5.03	5.56	6.58		0.9	0.6	2.2
April	11.59	9.14	9.30		9.7	8.3	9.3
May	12.70	7.82	8.00		13.1	14.5	15.1
June	7.46	9.47	10.36		22.2	19.7	20.3
July	6.34	10.97	9.22		25.1	21.7	22.8
August	10.92	8.71	8.97		23.1	20.9	22.2
September	4.44	7.14	8.51		21.0	16.8	18.2
October	4.13	6.58	5.79		9.9	11.4	11.9
November	3.21	4.37	5.23		3.2	2.9	4.3
December	3.96	3.20	5.33		–0.9	– 4.2	– 2.4
Total	75.90	79.95	84.68	Monthly Average	10.5	8.6	9.6

[a] ANL-E data obtained from Reference 3.

[b] Data obtained from the National Oceanic and Atmospheric Administration for the weather station at O'Hare International Airport. The average is for the years 1951–1980.

1.5. Geology

The geology of the ANL-E area consists of about 30 m (100 ft) of glacial drift on top of nearly horizontal bedrock consisting of Niagaran and Alexandrian dolomite underlain by shale and older dolomites and sandstones of Ordovician and Cambrian age. The glacial drift sequence is composed of the Wadsworth and Lemont Formations. Both are dominated by fine-grained drift units but also contain sandy, gravelly, or silty interbeds. Niagaran and Alexandrian dolomite is approximately 60 m (200 ft) thick but has an irregular, eroded upper surface.

The southern boundary of ANL-E follows the bluff of a broad valley, which is now occupied by the Des Plaines River and the Chicago Sanitary and Ship Canal. This valley was carved by waters flowing out of the glacial Lake Michigan about 11,000 to 14,000 years ago. The soils on the site were derived from glacial drift over the past 12,000 years and are primarily of the Morley series, that is, moderately well-drained upland soils with a slope ranging from 2 to 20%. The surface layer is a dark grayish-brown silt loam, the subsoil is a brown silty clay, and the underlying material is a silty clay loam glacial drift. Morley soils have a relatively low organic content in the surface layer, moderately slow subsoil permeability, and a large water capacity. The remaining soils along creeks, intermittent streams, bottomlands, and a few small upland areas are of the Sawmill, Ashkum, Peotone, and Beecher series, which are generally poorly drained. They have a black to dark gray or brown silty clay loam surface layer, high organic matter content, and a large water capacity.

1.6. Seismicity

No tectonic features within 135 km (62 mi) of ANL-E are known to be seismically active. The longest inactive local feature is the Sandwich Fault. Smaller local features are the Des Plaines disturbance, a few faults in the Chicago area, and a fault of apparently Cambrian age.

Although a few minor earthquakes have occurred in northern Illinois, none have been positively associated with particular tectonic features. Most of the recent local seismic activity is believed to be caused by isostatic adjustments of the earth’s crust in response to glacial loading and unloading, rather than by motion along crustal plate boundaries.

Several areas of considerable seismic activity are located at moderate distances (i.e., hundreds of kilometers) from ANL-E. These areas include the New Madrid Fault zone (southeast Missouri) in the St. Louis area, the Wabash Valley Fault zone along the southern Illinois-Indiana border, and the Anna region of western Ohio. Although high-intensity earthquakes have occurred along the New Madrid Fault zone, their relationship to plate motions remains speculative at this time.

According to estimates, ground motions induced by near and distant seismic sources in northern Illinois are expected to be minimal. However, peak accelerations in the ANL-E area may exceed 10% of gravity (the approximate threshold of major damage) once in approximately 600 years, with an error range of -250 to +450 years.

1.7. Groundwater Hydrology

Two principal aquifers are used as water supplies in the vicinity of ANL-E. The upper aquifer is the Niagaran and Alexandrian dolomite, which is approximately 60 m (200 ft) thick in the ANL-E area and has a piezometric surface between 15 and 30 m (50 and 100 ft) below the ground surface for much of the site. The lower aquifer is Galesville sandstone, which lies between 150 and 450 m (500 and 1,500 ft) below the surface. Maquoketa shale separates the upper dolomite aquifer from the underlying sandstone aquifer. This shale retards the hydraulic connection between the two aquifers.

Up until 1997, most groundwater supplies in the ANL-E area were derived from the Niagaran, and to some extent, the Alexandrian dolomite bedrock. Dolomite well yields are variable, but many approach 3,028 L/min (800 gal/min). In DuPage County, groundwater pumpage over the past 100 years has led to severe overdraft; in northeastern Illinois, the piezometric surface has been lowered in areas of heavy pumping. Delivery of Lake Michigan water to the major suburban areas is expected to relieve this problem. ANL-E now obtains all its domestic water from the City of Chicago water system.

1.8. Water and Land Use

Sawmill Creek flows through the eastern portion of the site. This stream originates north of the site, flows through the property in a southerly direction, and discharges into the Des Plaines River. Two small streams, one originating on site and the other just off site, which enter the site from the western boundary, combine to form Freund Brook, which discharges into Sawmill Creek. Along the southern margin of the property, the terrain slopes abruptly downward forming forested bluffs. These bluffs are dissected by ravines containing intermittent streams that discharge some site drainage into the Des Plaines River. In addition to the streams, various ponds and cattail marshes are present on the site. A network of ditches and culverts transports surface runoff toward the smaller streams.

The greater portion of the ANL-E site is drained by Freund Brook. Two intermittent branches of Freund Brook flow from west to east, drain the interior portion of the site, and ultimately discharge into Sawmill Creek. The larger, south branch originates in a marsh adjacent to the western boundary line of the site. It traverses wooded terrain for a distance of about 2 km (1.5 mi) before discharging into the Lower Freund Pond. The upper Freund Brook branch originates within the central part of the site and also discharges into the Lower Freund Pond.

Residential and commercial development in the area have resulted in the collection and channeling of runoff water into Sawmill Creek. Treated sanitary and laboratory wastewater from ANL-E are combined and discharged into Sawmill Creek at location 7M in Figure 1.1. In 2002, this effluent averaged 3.0 million L/day (0.8 million gal/day), which is similar to the averages for the last few years. The combined ANL-E effluent consisted of 64% laboratory wastewater and 36% sanitary wastewater. The water flow in Sawmill Creek upstream of the wastewater outfall averaged about 23 million L/day (6 million gal/day) during 2002.

Sawmill Creek and the Des Plaines River above Joliet, about 21 km (13 mi) southwest of ANL-E, receive very little recreational or industrial use. A few people fish in these waters downstream of ANL-E, and some duck hunting takes place on the Des Plaines River. Water from the Chicago Sanitary and Ship Canal is used by ANL-E for cooling towers and by others for industrial purposes, such as hydroelectric generators and condensers. ANL-E usage is approximately

1.1 million L/day (0.3 million gal/day). The canal, which receives Chicago Metropolitan Sanitary District effluent water, is used for industrial transportation and some recreational boating. Near Joliet, the river and canal combine into one waterway, which continues until it joins the Kankakee River to form the Illinois River about 48 km (30 mi) southwest of ANL-E. The Dresden Nuclear Power Station complex is located at the confluence of the Kankakee, Des Plaines, and Illinois Rivers. This station uses water from the Kankakee River for cooling and discharges the water into the Illinois River. The first downstream location where water is used as a community water supply system is at Peoria, which is on the Illinois River about 240 km (150 mi) downstream of ANL-E. In the vicinity of ANL-E, only subsurface water (from both shallow and deep aquifers) and Lake Michigan water are used for drinking purposes.

The principal recreational area near ANL-E is the Waterfall Glen Forest Preserve, which surrounds the site (see Section 1.2 and Figure 1.1). The area is used for hiking, skiing, biking, and horseback riding. Sawmill Creek flows south through the eastern portion of the preserve on its way to the Des Plaines River. Several large forest preserves of the Forest Preserve District of Cook County are located east and southeast of ANL-E and the Des Plaines River. The preserves include the McGinnis and Saganashkee Sloughs (shown in Figure 1.2), as well as other smaller lakes. These areas are used for picnicking, boating, fishing, and hiking. A small park located in the eastern portion of the ANL-E site (Location 12-0 in Figure 1.1) is for the use of ANL-E and DOE employees. A local municipality has use of the park for athletic events. The park also contains a day-care center for children of ANL-E and DOE employees.

1.9. Vegetation

ANL-E lies within the Prairie Peninsula of the Oak-Hickory Forest Region. The Prairie Peninsula is a mosaic of oak forest, oak openings, and tall-grass prairie occurring in glaciated portions of Illinois, northwest Indiana, southern Wisconsin, and sections of other states. Much of the natural vegetation of this area has been modified by clearing and tillage. Forests in the ANL-E region, which are predominantly oak and hickory, are somewhat limited to slopes of shallow, ill-defined ravines or low morainal ridges. Gently rolling to flat intervening areas between ridges and ravines were predominantly occupied by prairie before their use for agriculture. The prevailing successional trend on these areas, in the absence of cultivation, is toward oak-hickory forest. Forest dominated by sugar maple, red oak, and basswood may occupy more pronounced slopes. Poorly drained areas, streamside communities, and floodplains may support forests dominated by silver maple, elm, and cottonwood. Figure 1.4 shows the vegetation communities.

Early photographs of the site indicate that most of the land that ANL-E now occupies was actively farmed. About 75% was plowed field and 25% was pasture, open oak woodlots, and oak forests. Starting in 1953 and continuing for three seasons, some of the formerly cultivated fields were planted with jack, white, and red pine trees. Other fields are dominated by bluegrass.

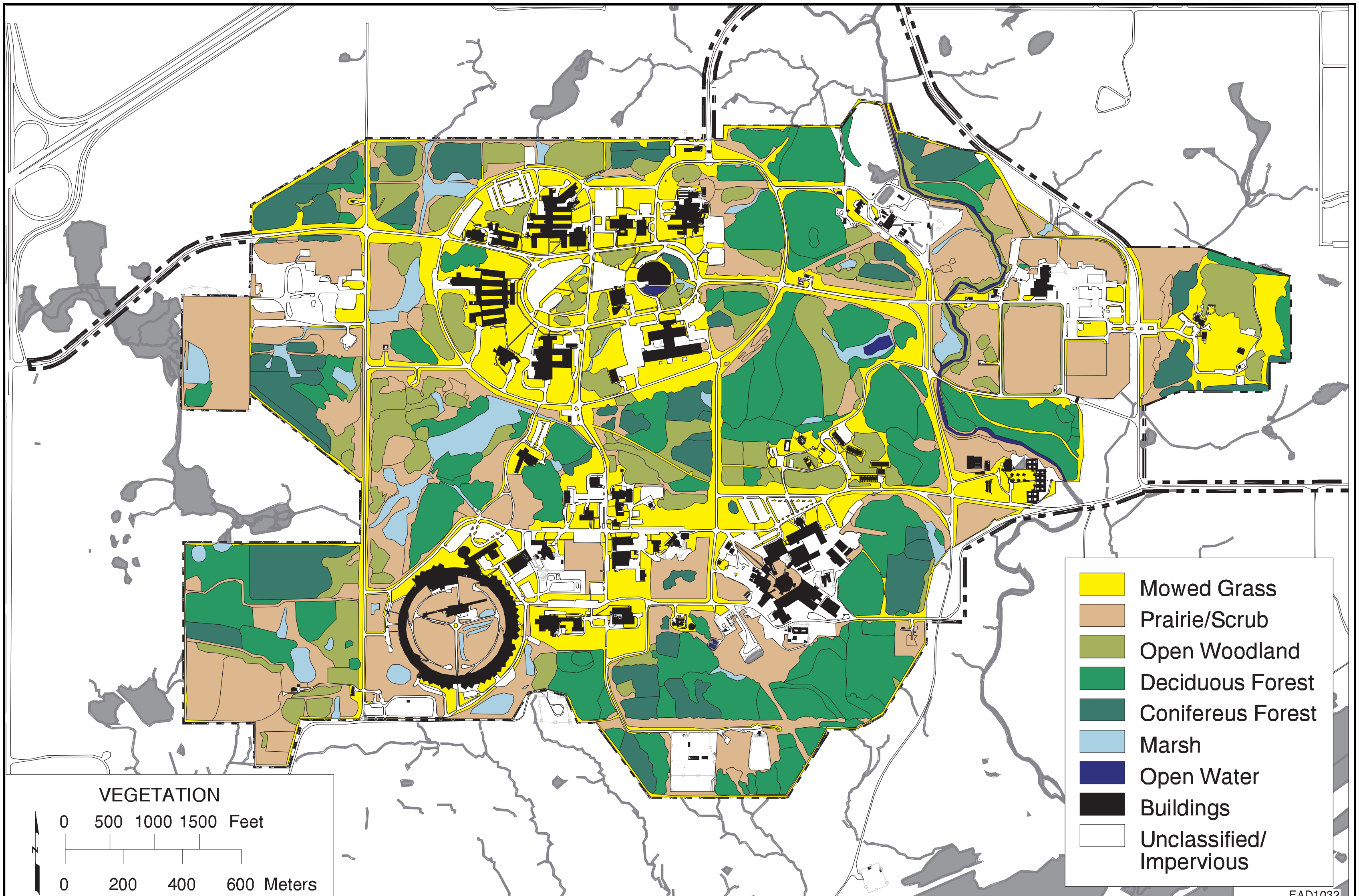


Figure 1.4 ANL-E Habitat

The deciduous forests on the remainder of the site are dominated by various species of oak, generally as large, old, widely spaced trees, which often do not form a complete canopy. Their large low branches indicate that they probably matured in the open, rather than in a dense forest. Other upland tree species include hickory, hawthorn, cherry, and ash.

DOE and ANL-E belong to Chicago Wilderness, a partnership of more than 100 public and private organizations that have joined forces to protect, restore, and manage 81,000 ha (200,000 acres) of natural areas in the Chicago metropolitan region. Several activities are planned or are in progress to enhance oak woodland, savanna, wetland, and prairie habitats on the approximately 285 ha (700 acres) undeveloped at the ANL-E site.

1.10. Fauna

Terrestrial vertebrates that are commonly observed or likely to occur on the site include about 5 species of amphibians, 7 of reptiles, 40 of summer resident birds, and 25 of mammals. More than a hundred other bird species can be found in the area during migration or winter; however, they do not nest on the site or in the surrounding region. An unusual species on the ANL-E site is the fallow deer, a European species that was introduced to the area by a private landowner prior to government acquisition of the property in 1947. A population of native white-tailed deer also inhabits the ANL-E site. The white-tailed and fallow deer populations are each maintained at a target density of 20 deer/mi^2 under an ongoing deer management program. Terrestrial invertebrate species and plants also reside on the ANL-E site.

Freund Brook crosses the center of the site. The gradient of the stream is relatively steep, and riffle habitat predominates. The substrate is coarse rock and gravel on a firm mud base. Primary production in the stream is limited by shading, but diatoms and some filamentous algae are common. Aquatic macrophytes include common arrowhead, pondweed, duckweed, and bulrush. Invertebrate fauna consist primarily of dipteran larvae, crayfish, caddisfly larvae, and midge larvae. Few fish are present because of low summer flows and high temperatures. Other aquatic habitats on the ANL-E site include beaver ponds, artificial ponds, ditches, and Sawmill Creek.

The biotic community of Sawmill Creek is relatively impoverished, which reflects the creek's high silt load, steep gradient, and historic release of sewage effluent from the Marion Brook sewage treatment plant north of the site. The fauna consists primarily of blackflies, midges, isopods, flatworms, segmented worms, and creek chubs. A few species of minnows, sunfishes, and catfish are also present. Clean-water invertebrates, such as mayflies and stoneflies, are rare or absent. Fish species that have been recorded in ANL-E aquatic habitats include black bullhead, bluegill, creek chub, golden shiner, goldfish, green sunfish, largemouth bass, stoneroller, and orange-spotted sunfish.

The U.S. Fish and Wildlife Service (USFWS) has rated the Des Plaines River system, including ANL-E streams, as “poor” in terms of the fish species present because of domestic and industrial pollution and stream modification.

1.11. Cultural Resources

ANL-E, which is located in the Illinois and Michigan Canal National Heritage Corridor, is situated in an area known to have a long and complex cultural history. All periods listed in the cultural chronology of Illinois, with the exception of the earliest period (Paleo-Indian), have been documented in the ANL-E area either by professional cultural resource investigators or through interviews of local artifact collectors by ANL-E staff. A variety of site types, including mounds, quarries, lithic workshops, and habitation sites, have been reported by amateurs within a 25-km (16-mi) radius.

Forty-six archaeological sites have been recorded at ANL-E. These sites include prehistoric chert quarries, special purpose camps, base camps, and historical farmsteads. The range of human occupation spans several time periods (Early Archaic through Mississippian Prehistoric to Historical). Three sites have been determined to be eligible for the *National Register of Historic Places* (NRHP); 20 sites have been determined to be ineligible; and 23 sites have not been evaluated for eligibility.

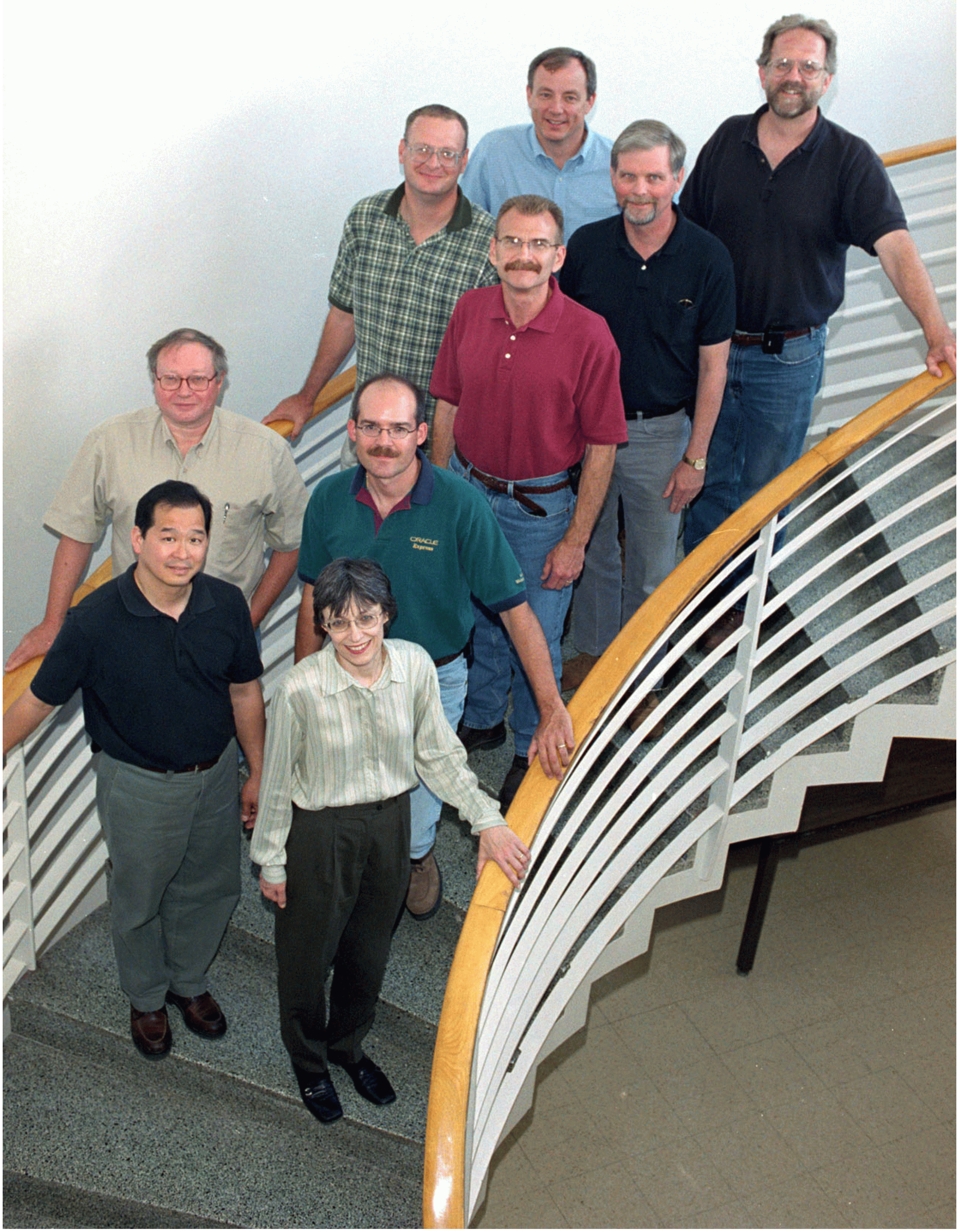
Cultural resources also include historic structures. Historic property surveys over the past several years identified two areas at ANL-E that are eligible for listing on the NRHP as historic districts, as well as several buildings that are individually eligible for listing on the NRHP.

1.12. Endangered Species

No federal-listed threatened or endangered species are known to occur on the ANL-E site, and no critical habitat of federally listed species exists on the site. Three federal-listed endangered species and one federal-listed threatened species are known to inhabit the Waterfall Glen Forest Preserve that surrounds the ANL-E property or are known to occur in the area.

The Hine’s emerald dragonfly (*Somatochlora hineana*), federal and state listed as endangered, occurs in locations with calcareous seeps and wetlands along the Des Plaines River floodplain. Leafy prairie clover (*Dalea foliosa*), which is federal and state listed as endangered, is associated with dolomite prairie remnants of the Des Plaines River valley; two planted populations of this species occur in Waterfall Glen Forest Preserve. An unconfirmed capture of an Indiana bat (*Myotis sodalis*), which is federal and state listed as endangered, indicates that this species may occur in the area. The federal-listed threatened lakeside daisy (*Hymenoxys herbasea*) has a planted population in Waterfall Glen Forest Preserve. Additional state-listed species that occur in the area are identified in Section 2.10. Of these, Kirtland's snake, pied-billed grebe, black-crowned night heron, brown creeper, and red-shouldered hawk have been observed on ANL-E property.

2. COMPLIANCE SUMMARY



ANL-E is a government-owned, contractor-operated R&D facility that is subject to environmental statutes and regulations administered by the U.S. Environmental Protection Agency (EPA), the Illinois Environmental Protection Agency (IEPA), U.S. Army Corps of Engineers (USACE), and the State Fire Marshal, as well as to numerous DOE Orders and Executive Orders. A detailed listing of applicable regulations is contained in DOE Order 5400.1,[1] which establishes DOE's policy concerning environmental compliance. The status of ANL-E during 2002 with regard to these authorities is discussed in this chapter.

To ensure compliance with both the letter and spirit of these requirements, ANL-E has made a commitment to comply with all applicable environmental requirements, as described in the following policy statement:

> The policy of Argonne National Laboratory is that its activities are to be conducted in such a manner that worker and public health and safety and protection of the environment are given the highest priority. The Laboratory will comply with all applicable federal and state health, safety, and environmental laws, regulations, and orders, so as to protect the health and safety of workers and the public and to minimize accidental damage to property.

2.1. Clean Air Act

The Clean Air Act (CAA) is a federal statute that sets emission limits for air pollutants and determines emission limits and operating criteria for certain hazardous air pollutants. The program for compliance with the requirements is implemented by individual states through a State Implementation Plan (SIP) that describes how that state will ensure compliance with the air quality standards for stationary sources.

A number of major changes to the CAA were made with the passage of the Clean Air Act Amendments of 1990. Under Title V of the Clean Air Act Amendments of 1990, ANL-E was required to submit a Clean Air Act Permit Program (CAAPP) application to the IEPA for a sitewide, federally enforceable operating permit to cover emissions of all regulated air pollutants at the facility. This permit supersedes the prior individual state air pollution control permits. All facilities designated as major emission sources for regulated air pollutants are subject to this requirement. ANL-E meets the definition of a major source because of potential emissions of oxides of nitrogen in excess of 22.68 t/yr (25 tons/yr) and sulfur dioxide in excess of 90.72 t/yr (100 tons/yr) at the Building 108 Central Heating Plant (see Table 2.4).

Facilities subject to Title V must characterize emissions of all regulated air pollutants, not only those that qualify them as major sources. In addition to oxides of nitrogen and sulfur dioxide, ANL-E also must evaluate emissions of carbon monoxide, particulates, volatile organic compounds (VOCs), hazardous air pollutants (HAPs – a list of 188 chemicals, including radionuclides), and ozone-depleting substances. The air pollution control permit program requires that facilities pay annual fees on the basis of the total amount of regulated air pollutants (except carbon monoxide) they are allowed to emit.

Comments on the preliminary draft ANL-E CAAPP Permit were submitted to the IEPA prior to the January 19, 2001, deadline, and the EPA sent out the final draft permit for public comment and review on February 14, 2001. A public hearing was not requested, and the finalized CAAPP permit was issued on April 3, 2001.

The ANL-E site contains a large number of air emission point sources. The vast majority are laboratory ventilation systems that are exempt from state permitting requirements, except for those systems emitting radionuclides. With the issuance of the ANL-E CAAPP Title V Permit on April 3, 2001, all previous operating permits, with two exceptions for prior open burning permits, were incorporated into this sitewide permit for all emission sources and activities. The open burning permits are renewed each year. In 2002, two construction permits were issued; one for the Building 205 counting area ventilation system and one for the Building 306 waste building sheds. The permitted air emission sources are listed in Table 2.15.

2.1.1. National Emission Standards for Hazardous Air Pollutants

The National Emission Standards for Hazardous Air Pollutants (NESHAPs) constitute a body of federal regulations that set forth emissions limits and other requirements, such as monitoring, record keeping, and operational and reporting requirements, for activities generating emissions of certain HAPs. The only standards affecting ANL-E operations are those for asbestos and radionuclides. By the time of the issuance of the sitewide ANL-E Title V Permit, the IEPA had issued a total of 23 air pollution control permits to ANL-E for NESHAPs sources. All ANL-E operating NESHAPs Permits were incorporated into the sitewide ANL-E Title V Permit.

In 2002, the EPA proposed a number of additional NESHAPs that could have potential impacts on ANL-E operations. Specifically, NESHAPs (also known as Maximum Achievable Control Technology or MACT standards) were proposed to regulate HAP emissions from institutional boilers, reciprocal internal combustion engines, and engine testing facilities.

These MACT standards would be applicable to major HAP sources (facilities with emissions or potential emissions of 9 t/yr (10 tons/yr) of any HAP, or 23 t/yr (25 tons/yr) of all combined HAPs). While ANL-E had not been categorized as a major HAP source in the original CAAPP application, HAP emissions from combustion sources had not been included, because at the time, the IEPA indicated that reliable emission factors were not available. In 2002, the IEPA stated that HAP emissions from combustion sources needed to be included to determine applicability of the upcoming MACT standards.

On the basis of potential to emit, it was determined that by considering combustion sources, ANL-E would now be categorized as a major HAP source and therefore subject to the MACT standards when they became final in 2003. As a consequence, an application for a minor permit modification was prepared and submitted to the IEPA on November 18, 2002, requesting that an enforceable limit of 11,000 t/yr (12,000 tons/yr) of coal for Boiler No. 5 be included in the CAAPP Permit. This limit would reduce ANL-E's potential HAP emissions to levels below the major source threshold.

2.1.1.1. Asbestos Emissions

Many buildings on the ANL-E site contain large amounts of asbestos-containing material (ACM), such as thermal system insulation around pipes and tanks, spray-applied surfacing material for fireproofing, floor tile, and asbestos-cement (Transite) panels. This material is removed as necessary during renovations or maintenance of equipment and facilities. The removal and disposal of this material are governed by the asbestos NESHAPs.

ANL-E maintains an asbestos abatement program designed to ensure compliance with these and other regulatory requirements. In general, ACM is removed from buildings either by specially trained ANL-E crews (for small-scale, short-duration projects) or by outside contractors (for large-scale insulation removal projects). All removal work is performed in accordance with both NESHAP and Occupational Safety and Health Administration requirements governing worker safety at ACM removal sites.

Approximately 79 m^3 (2,800 ft^3) of ACM was removed from ANL-E buildings during 2002. The 77 small removal projects that were completed generated 31 m^3 (1,100 ft^3) of ACM waste; the remaining 48 m^3 (1,700 ft^3) generated resulted from 9 large removal projects. Table 2.1 provides asbestos abatement information for the large removal projects. The IEPA was notified during December 2002, that no more than 71 m^3 (2,500 ft^3) of ACM waste is expected to be generated from small-scale projects during 2003.

A separate portion of the asbestos removal standards contains requirements for disposing of ACM. Off-site shipments are to be accompanied by completed shipping manifests. Asbestos disposal information is provided in Table 2.2. Until closure of the ANL-E landfill in September 1992, asbestos from small-scale projects was disposed of on site in a designated area of the 800 Area Landfill.

TABLE 2.1

Large-Scale Asbestos Abatement Projects DOE/IEPA Notification, 2002

Completion Date	Asbestos Abatement Contractor	Notification Quantity ft	Notification Quantity ft^2	Material	Building	Disposal Quantity (ft^3)	Landfill
4/6/02	ANL-E PFS[a] Waste Management Operations	0	530	Floor Tile	223	24	Streator[b]
5/22/02	ANL-E PFS Waste Management Operations	0	2,800	Floor Tile	202	106	Streator
7/15/02	ANL-E PFS Waste Management Operations	0	200	HVAC Duct Insulation	212	232	Streator
7/30/02[c]	ANL-E PFS Waste Management Operations	0	994	Floor Tile	306	112	Environtech[d]
8/23/02[c]	ANL-E PFS Waste Management Operations	0	240	Floor Tile	205	16	Hanford[e]
8/28/02	Environmental Cleansing Corporation	65	135	Chiller and Pipe Insulation	211	135	Streator
9/25/02	Environmental Cleansing Corporation	0	3,500	Floor Tile and Mastic	617	660	Streator
9/30/02	Environmental Cleansing Corporation	94	1,420	Spray-on and Pipe Insulation	221	270	Streator
12/20/02[c]	Universal Asbestos Removal	0	2,000	Floor Tile and Mastic	203	124	Environtech
					Total	1,679	

[a] PFS = Plant Facilities and Services.

[b] Streator Area Landfill, Streator, IL.

[c] Courtesy notification, nonfriable material removed intact.

[d] Environtech Landfill, Morris, IL.

[e] On site pending shipment to DOE Hanford Facility, Richland, WA.

2.1.1.2. Radionuclide Emissions

The NESHAPs standard for radionuclide emissions from DOE facilities (40 CFR Part 61, Subpart H) establishes the emission limits for the release of radionuclides other than radon to the air and the corresponding requirements for monitoring, reporting, and record keeping. A number of emissions points at ANL-E are subject to these requirements and are operated in compliance with them. These points include ventilation systems for hot cell facilities for storage and handling of radioactive materials (Buildings 205 and 212), ventilation systems for particle accelerators (Building 375, IPNS facility, and the Building 411 APS linac), and several ventilation systems associated with the Building 350 NBL. In addition, many ventilation systems and fume hoods are used occasionally for processing small quantities of radioactive materials.

TABLE 2.2

Disposal of Asbestos-Containing Materials, 2002

Project Size	Landfill	Quantity (ft^3)	Total Quantity (ft^3)
Small-scale	Streator[a]	580	1,094
	Environtech[b]	514	
Large (IEPA Notification)	Streator	1,427	1,679
	Environtech	236	
	Hanford[c]	16[d]	
	Total		2,773

[a] Streator Area Landfill, Streator, IL.

[b] Environtech Landfill, Morris, IL.

[c] DOE Hanford Facility, Richland, WA.

[d] Pending shipment to Hanford.

The amount of radioactive material released to the atmosphere from ANL-E emissions sources is extremely small. The maximum off-site dose to a member of the general public for 2002 was 0.039 mrem, excluding radon-220 and radon-222, which is 0.4% of the 10 mrem/yr EPA standard. Section 4.6.1 contains a more detailed discussion of these emissions points and compliance with the standard.

2.1.2. Conventional Air Pollutants

The ANL-E site contains a number of sources of conventional air pollutants, including a steam plant; gasoline and ethanol/gasoline blend fuel-dispensing facilities; two alkali metal reaction booths; a dust collection system; the engine test facility; and fire training activities. These facilities are operated in compliance with applicable regulations and permit conditions. Table 2.15 gives the emissions sources operating under the ANL-E CAAPP Title V Permit.

The Title V Permit requires continuous opacity and sulfur dioxide monitoring of the smoke stack from Boiler No. 5, the only one of the five boilers at the steam plant equipped to burn coal. The permit requires submission of a quarterly report listing any exceedances beyond emissions limits for this boiler (30% opacity averaged over 6 minutes and 0.82 kg [1.8 lb] of sulfur dioxide per million Btu averaged over a 1-hour period). Table 2.3 gives the hours that Boiler No. 5 operated on low-sulfur coal during 2002, as well as the amount of low-sulfur coal burned. There were no exceedances at Boiler No. 5 in 2002.

An annual compliance certification must be submitted to the IEPA and the EPA each May 1 for the previous calendar year, detailing any deviations from the permit and subsequent corrective actions. Two deviations were reported for 2002.

The first deviation involved noncompliance with the cold-cleaning rule, which began when the permit commenced in April 2001 and is still in effect. Efforts are ongoing in working with the IEPA and EPA in preparing a petition for an adjusted standard for submittal to the Illinois Pollution Control Board. The petition will request an adjusted standard to the cold-cleaning rule, to allow the use of solvents exceeding the vapor pressure limits for R&D activities when no acceptable alternatives can be employed. Both agencies are supportive of ANL-E's proposal, and submittal is expected in 2003.

TABLE 2.3

Boiler No. 5 Operation, 2002

Month	Operated (hours)	Low-Sulfur Coal Burned (tons)
January	550.0	1,884.7
February	569.8	1,597.5
March	0	0
April	0	0
May	0	0
June	0	0
July	0	0
August	0	0
September	0	0
October	0	0
November	231.0	780.8
December	480.8	1,592.9
Total	1,831.6	5,855.9

The second deviation involved the discovery of four unpermitted rooms in Building 212 with potential radionuclide emissions. Corrective action in 2003 will include submittal of a permit application and inclusion of the emissions in the annual NESHAPs report.

Landfill gas monitoring is conducted quarterly at the 800 Area Landfill via 3 gas wells placed into the waste area and 10 gas wells at the perimeter of the landfill; Figure 2.1 shows their locations. In addition to the wells, ambient air is sampled in two nearby buildings and at three open-air locations to assess the presence of methane. The gas monitoring near the landfill determines whether or not methane is migrating from the landfill. Results indicate that methane is being generated; however, no migration of this compound has been noted.

Fuel-dispensing facilities include a commercial service station and the Building 46 Grounds and Transportation facility. Except for ethanol vapors from alternate fuel usage, these facilities have VOC emissions typical of any commercial gasoline service station.

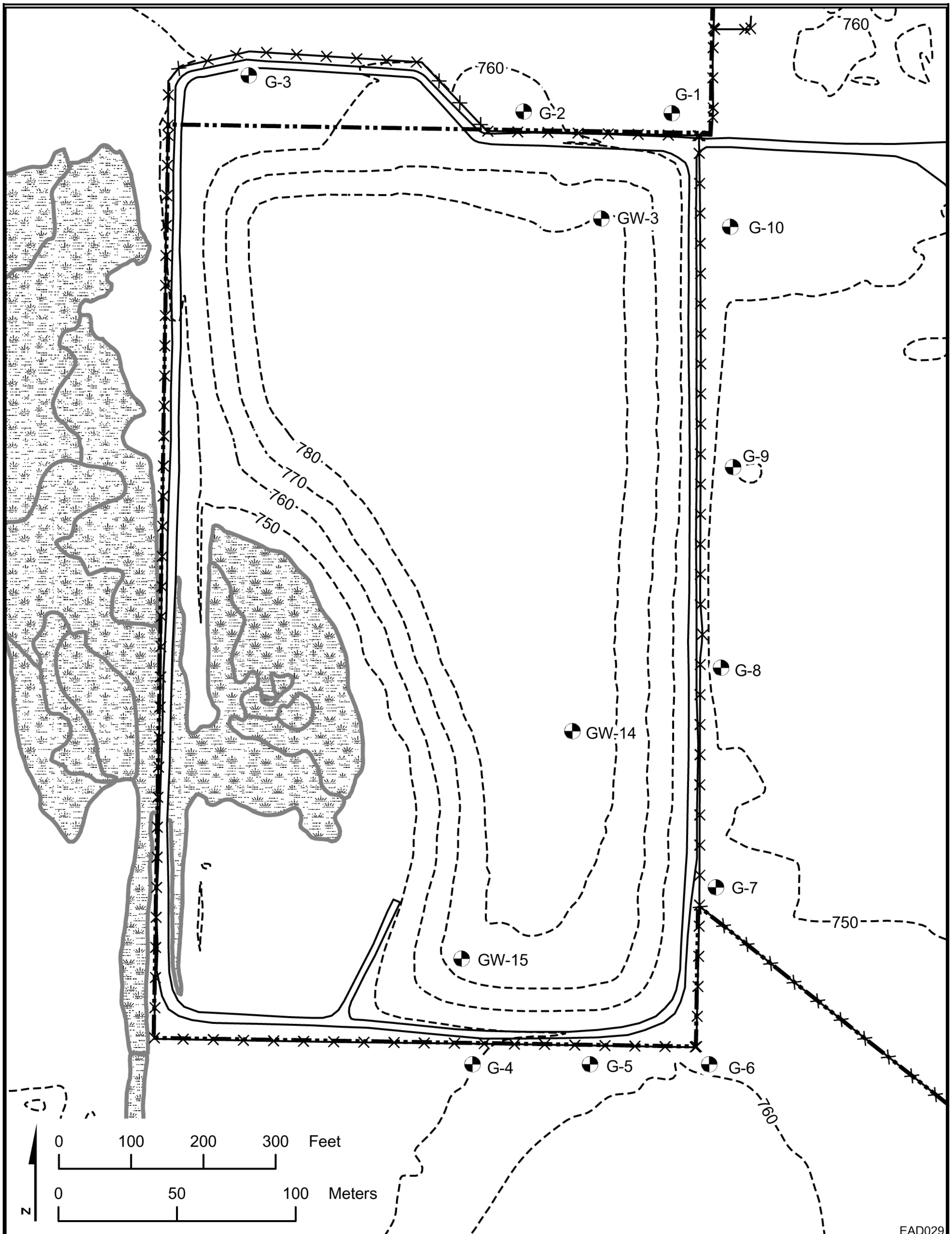


Figure 2.1 800 Area Landfill Gas Monitoring Wells

Pursuant to *Illinois Administrative Code*, Title 35, Part 254 (35 IAC Part 254), ANL-E submits an emissions summary to the IEPA each May 1 for the previous year. The summary for 2002 is presented in Table 2.4.

2.1.3. Clean Fuel Fleet Program

As mandated under the CAA and 35 IAC Part 241, the fourth annual Clean Fuel Fleet Program report was submitted to the IEPA on October 16, 2002, for vehicle acquisitions in Model Year (MY) 2002 (September 1, 2001–August 31, 2002). Forty-three light-duty vehicles and five heavy-duty vehicles were reported. Total vehicle acquisitions were in compliance with the percentages required by the Clean Fuel Fleet Program.

2.2. Clean Water Act

The Clean Water Act (CWA) was established in 1977 as a major amendment to the Federal Water Pollution Control Act of 1972 and was modified substantially by the Water Quality Act of 1987. Section 101 of the CWA provides for the restoration and maintenance of water quality in all waters throughout the country, with the ultimate goal of "fishable and swimmable" water quality. The act established the National Pollutant Discharge Elimination System (NPDES) permitting system, which is the regulatory mechanism designed to achieve this goal. The authority to implement the NPDES program has been delegated to those states, including Illinois, that have developed a program substantially the same and at least as stringent as the federal NPDES program.

The 1987 amendments to the CWA significantly changed the thrust of regulatory activities. Greater emphasis is placed on monitoring and control of toxic constituents in wastewater, the permitting of outfalls composed entirely of storm water, and the imposition of regulations governing sewage sludge disposal. These changes in the NPDES program resulted in much stricter discharge limits in the 1990s and greatly expanded the number of chemical constituents monitored in the effluent.

2.2.1. Wastewater Discharge Permitting

The NPDES permitting process administered by the IEPA is the primary tool for enforcing the requirements of the NPDES program. Before wastewater can be discharged to any receiving stream, each wastewater discharge point (outfall) must be characterized and described in a permit application. The IEPA then issues a permit that, for each outfall, contains numeric limits and monitoring frequencies on certain pollutants likely to be present and sets forth a number of additional specific and general requirements, including sampling and analysis schedules and reporting and

TABLE 2.4

2002 Annual Emissions Report: Emissions Summary

Building No. and Source	CO[a]	NO_x	Particulate	SO_2	VOM	Lead	MC[b]	TCA[b]
46: Ethanol/Gasoline	–[c]	–	–	–	0.5	–	–	–
46: 10,000 Gal Gasoline	–	–	–	–	12.4	–	–	–
108: Boiler 1	24,382	81,273	887	177	414	–	–	–
108: Boiler 2	2,038	6,792	74	15	35	–	–	–
108: Boiler 3	8,370	27,919	305	61	142	–	–	–
108: Boiler 4	9,958	33,193	362	72	169	–	–	–
108: Boiler 5 (coal-fired)	30,451	64,403	457	126,023	213	–	–	–
108: Boiler 5 (gas-fired)	3,773	5,489	137	27	64	–	–	–
108: Sulfuric Acid Tank[d]	–	–	–	–	–	–	–	–
200: Peak Shaving Generator	0	0	0	0	0	–	–	–
200: M-Wing Hot Cells (R)[e]	–	–	–	–	–	–	–	–
202: Peak Shaving Generator	0	0	0	0	0	–	–	–
206: Alkali Reaction Booth (R)[e]	–	–	–	–	–	–	–	–
212: Alpha Gamma Hot Cell (R)[e]	–	–	–	–	–	–	–	–
212: Building Exhausts[d]	–	–	–	–	–	–	–	–
300: 8,000 Gal Gasoline	–	–	–	–	42.4	–	–	–
300: 10,000 Gal Gasoline	–	–	–	–	8.3	–	–	–
300: 6,000 Gal Gasoline	–	–	–	–	13.8	–	–	–
301: Hot Cell D&D Project (R)[e]	–	–	–	–	–	–	–	–
303: Mixed Waste Storage (R)[e]	–	–	–	–	–	–	–	–
306: Building Vents (R)[e]	–	–	<1	–	–	–	–	–
306: Bulking Sheds	–	–	–	–	114	–	3.0	0.9
306: Vial Crusher/Chemical Photooxidation Unit (R)[e]	–	–	–	–	0	–	–	–
308: Alkali Reaction Booth[d]	–	–	-	–	–	–	–	–
315: MACE Project (R)[e]	120	–	–	–	–	–	–	–
317: Lead Brick Cleaning (R)[e]	–	–	–	–	–	0	–	–
330: CP-5 D&D Project (R)[e]	–	–	–	–	–	–	–	–
331: Rad Waste Storage (R)[e]	–	–	–	–	–	–	–	–
350: NBL Pu/U Hoods (R)[e]	–	–	–	–	–	–	–	–
363: Central Shop Dust Collector[d]	–	–	-	–	–	–	–	–
368: Woodshop Dust Collector[d]	–	–	-	–	–	–	–	–
370: Alkali Reaction Booth[d]	–	–	-	–	–	–	–	–
375: Intense Pulsed Neutron Source (R)[e]	–	–	–	–	–	–	–	–
400: APS Facility (R)[e]	–	72	–	–	–	–	–	–
400: APS Generator Caterpillar (1 unit)	453	2,360	84	195	56	–	–	–
400: APS Generator Kohler (2 units)	2,234	3,015	118	619	107	–	–	–
595: Lab Wastewater Plant (R)[e]	–	–	–	–	74.0	–	0.4	0
Lab Rad Hoods (R)[e]	–	–	–	–	–	–	–	–
PCB Tank Cleanout	–	–	–	–	0	–	–	–
Torch Cut Lead-Based Paint[d]	–	–	-	–	–	–	–	–
Transportation Research Facility	2,501	5,078	420	381	536	–	–	–
WMO Portable HEPA - (6) (R)[e]	–	–	<1	–	–	–	–	–
Total (lb/yr)	84,280	229,593	2,843	127,571	2,001	0	3.4	0.9
Total (ton/yr)	42.14	114.80	1.42	63.79	1.00	0	0.02	0.0005
CAAPP Permit Limit (tons/yr)	(397.60)[f]	1,014.10	49.02	798.20	19.65	0.11	–	–

Footnotes on next page.

TABLE 2.4 (Cont.)

[a] Abbreviations: APS = Advanced Photon Source, CP-5 = Chicago Pile-Five reactor, CO = carbon monoxide, D&D = decontamination and decommissioning, HEPA = high-efficiency particulate air filter, MACE = melt attack and coolability experiment, MC = methylene chloride, NBL = New Brunswick Laboratory, NO_x = oxides of nitrogen, PCB = polychlorinated biphenyl, Pu = plutonium, SO_2 = sulfur dioxide, TCA = 1,1,1-trichloroethane, U = uranium, VOM = volatile organic material, and WMO = Waste Management Operations.

[b] These compounds are hazardous air pollutants (HAPs) but are not classified as VOM.

[c] A dash indicates that the pollutant is not permitted from that particular unit (or it is classified as an insignificant activity); a zero means that the source is permitted for emissions of that pollutant but that there were no emissions for the year.

[d] These sources have been designated as insignificant in the CAAPP.

[e] (R) = radionuclide source regulated by NESHAPs (40 CFR Part 61 Subpart H).

[f] Not a permit limit, but is the maximum potential emission level for CO.

record keeping requirements. NPDES permits are effective for five years and must be renewed by the submission of a permit application at least 180 days prior to the expiration of the existing permit. Wastewater discharge at ANL-E is permitted by NPDES Permit No. IL 0034592. This permit was renewed during 1994 (effective October 30, 1994), was modified in 1995 (effective August 24, 1995), and was to expire on July 1, 1999. An application to renew the existing permit was submitted timely to the IEPA on December 28, 1998. In 2001, a previously unknown storm water discharge point was discovered and characterized. On February 12, 2002, ANL-E submitted a supplementary permit application covering this outfall and an oil water separator for Building 376, along with the comments regarding the preliminary draft NPDES Permit. Just prior to the end of 2002, the IEPA issued the “Final Draft Permit” for public comment. At the end of the year, ANL-E was preparing comments to be forwarded to the IEPA regarding the draft permit. Therefore, as provided for in the IEPA regulations, ANL-E continues to operate under the existing permit until the IEPA issues a renewal permit.

Wastewater at ANL-E is generated by a number of activities and consists of sanitary wastewater (from restrooms, cafeteria sinks and sinks in certain buildings and laboratories, and steam boiler blowdown), laboratory wastewater (from laboratory sinks and floor drains in most buildings), and storm water. Water softener regenerant from boiler house activities is discharged to the DuPage County sewer system. Cooling water and cooling tower blowdown are discharged into storm water ditches that are monitored as part of the NPDES permit. The current permit authorizes the release of wastewater from 40 separate outfalls, most of which discharge directly or indirectly into Sawmill Creek. Two of the outfalls are internal sampling points that combine to form the main wastewater outfall, Outfall 001. Table 2.5 lists these outfalls; Figure 2.2 shows their locations.

2.2.1.1. NPDES Permit Activities

Total dissolved solids (TDS) analyses results historically have demonstrated an annual cycle, culminating in periodic discharge limit violations occurring in the winter at Outfall 001.

TABLE 2.5

Characterization of NPDES Outfalls at ANL-E, 2002

Outfall	Description	Average Flow[a]
001A	Sanitary Treatment Plant	0.292
001B	Laboratory Treatment Plant	0.513
001	Combined Outfall	0.805
003A	Swimming Pool	0.0
003B	300 Area (Condensate)	0.013
003C	Building 205 Footing Tile Drainage	0.023
003D&E	Steam Trench Drainage (Condensate)	0.007/0.003
003F	Building 201 Fire Pond Overflow Storm Water	0.068
003G	North Building 201 Storm Sewer (Condensate)	0.025
003H	Building 212 Cooling Tower Blowdown	<0.001
003I	Buildings 200 and 211 Cooling Tower Blowdown	0.016
003J	Building 213 and Building 213 Parking Lot Storm Water	0.003
004	Building 203 Cooling Tower and Building 221 Footing Drainage and Storm Water	0.021
005A	Westgate Road Storm Water	Storm Water Only
005B	800 Area East Storm Water	Storm Water Only
005C	Building 200 West	0.016
005D	Storm Water	Storm Water Only
005E	Building 203 West Footing Drainage and Condensate	0.012
006	Cooling Tower Blowdown and Storm Water	0.024
007	Domestic Cooling Water for Compressor and Storm Water	0.019
008	Transportation and Grounds Storm Water	0.007
010	Coal Pile Runoff Emergency Overflow	Storm Water Only
101	North Fence Line Marsh Storm Discharge	Storm Water Only
102	100 Area Storm Water Discharge	Storm Water Only
103	Southeast 100 Area Storm Water	Storm Water Only
104	Northern East Area Storm Water Discharge	Storm Water Only
105A&B	Building 40 Storm Water Discharge	Storm Water Only
106A&B	Southern East Area Storm Water Discharge	Storm Water Only
108	Eastern 300 Area Storm Water and Cooling Water	0.019
110	Shooting Range Storm Water Discharge	Storm Water Only
111	319 Landfill and Northeast 317 Area	Storm Water Only
112A&B	Southern and Western 317 Area	Storm Water Only
113	Southern and Eastern 800 Area Landfill Storm Water Runoff	0.001
114	Northern and Western 800 Area Landfill Storm Water Runoff	<0.001
115	314, 315, and 316 Cooling Water, Eastern and Southern APS Area	0.003
116	Water Treatment Plant and Storm Water	0.003

[a] Flow is measured in million gallons per day, except for outfalls with storm water only.

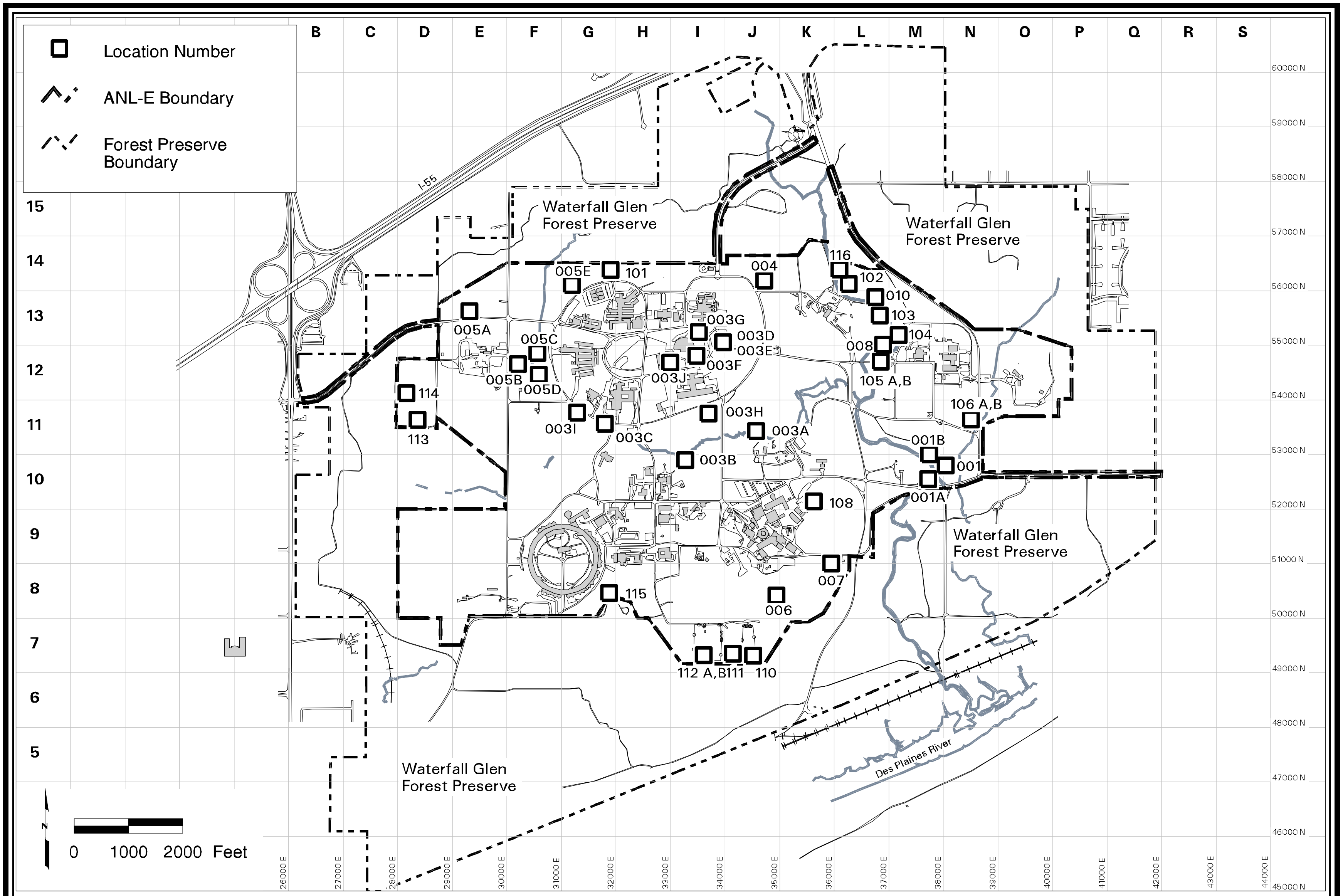


Figure 2.2 NPDES Permit Locations

Investigations into the causes of the heightened TDS concentration during winter have focused on three sources of increased TDS contribution during the winter months: (1) increased boiler activity with its associated increase in high TDS wastewater (i.e., boiler blowdown), (2) salt usage in the boiler house area that drains to the boiler house pond, and (3) road salt used for snowmelt. To deal effectively with these problems, the boiler house equalization pond was routed to DuPage County for periodic discharge of up to 227,125 L/day (60,000 gal/day).

To accomplish this, ANL-E completed an application to DuPage County to allow the discharge of this wastewater under the existing permit with the county. An application was also sent to the IEPA. Historically, all wastewater in the equalization pond was directed to the Sanitary Wastewater Treatment Plant (SWTP). The permit application was acted upon by the IEPA, and a new permit was issued covering this discharge (see Table 2.15). Redirection of the equalization pond wastewater to DuPage County is intended to be accomplished only during the heating season in late fall and winter. This was begun in a testing mode late in 2001, and then put into service in the spring of 2002. Experience to date seems to indicate that this action has reduced TDS concentrations at the wastewater treatment plant (WTP) during the heating season.

2.2.1.2. Compliance with NPDES Permit

Wastewater is treated at ANL-E in two independent treatment systems, the sanitary system and the laboratory system. The sanitary wastewater collection and treatment system collects wastewater from sanitation facilities, the cafeteria, office buildings, and other portions of the site that do not contain radioactive or hazardous materials. This wastewater is treated in a biological wastewater treatment system consisting of primary clarifiers, trickling filters, final clarifiers, and slow sand filters. Wastewater generated by research-related activities, including those which utilize radioactive materials that could find their way into the sewer, flows to a series of retention tanks located in each building that are pumped to the laboratory wastewater sewer after radiological analysis and release certification. Treatment in the Laboratory Wastewater Treatment Plant (LWTP) consists primarily of aeration, solids-contactor clarification, and pH adjustment. Additional steps can be added, including powder-activated carbon addition for organic removal, alum addition, and polymer addition or adjustment, if analysis demonstrates that any of these are required.

Figure 2.3 shows the two wastewater treatment systems that are located adjacent to each other. The volume of wastewater discharged from these facilities in 2002 averaged 1.11 million L/day (0.29 million gal/day) for the sanitary wastewater and 1.95 million L/day (0.51 million gal/day) for the laboratory process wastewater.

Results of the routine monitoring required by the NPDES Permit are submitted monthly to the IEPA in a Discharge Monitoring Report (DMR). As required by the permit, any exceedance of permit limits or conditions is reported by telephone to the IEPA within 24 hours, and a written

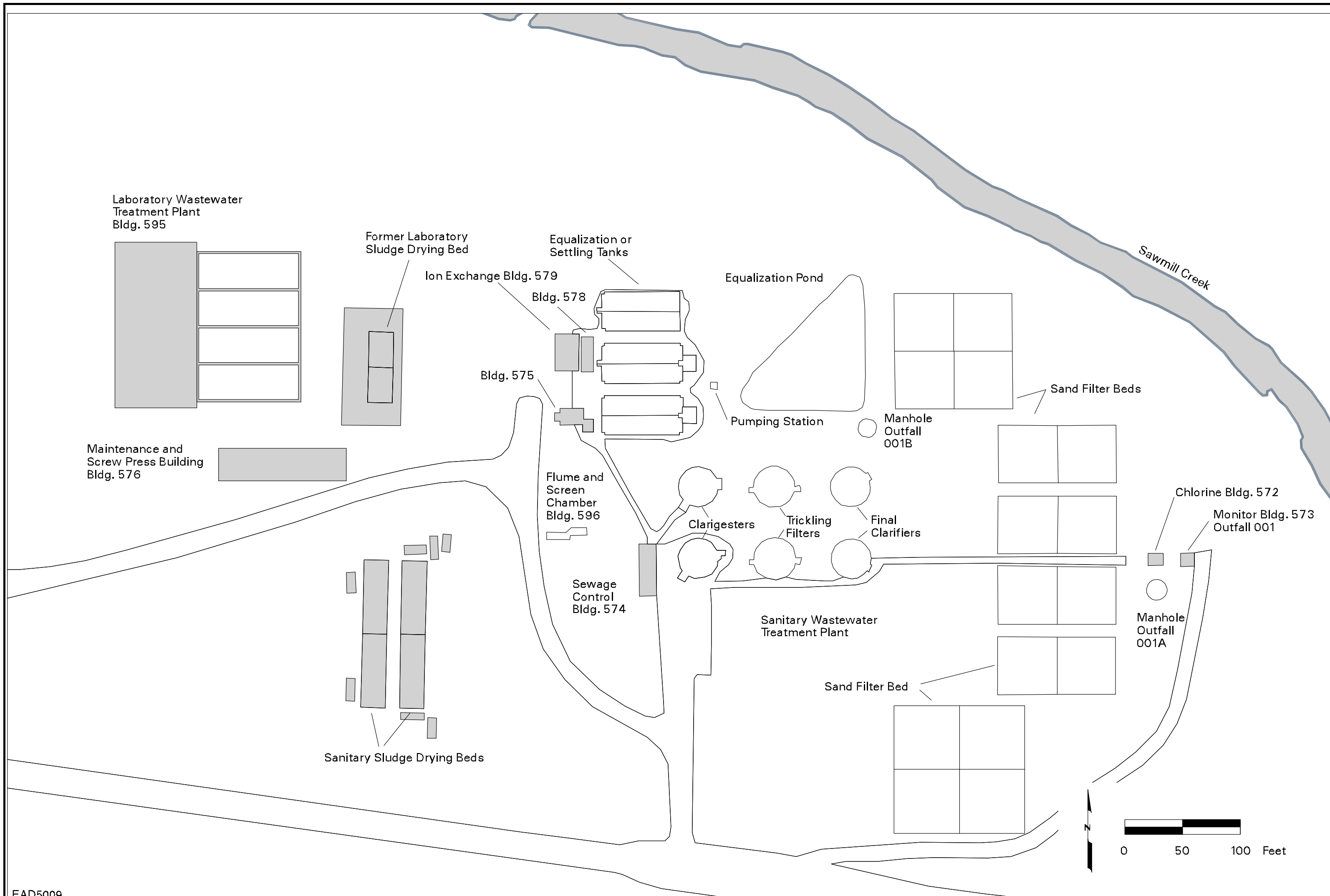


Figure 2.3 ANL-E Wastewater Treatment Plant

explanation of the exceedance is submitted with each DMR. During 2002, there were six exceedances of NPDES Permit limits out of approximately 1,600 measurements. Two were exceedances of the TDS limit at Outfall 001 and were attributed to road salt associated with snowmelt. Four of the exceedances were total residual chlorine exceedances at Outfall 007 related to a domestic water leak from a fire hydrant valve. Figure 2.4 presents the data for the total number of exceedances each year over the past 13 years.

2.2.1.3. Priority Pollutant Analysis and Biological Toxicity Testing

The NPDES Permit requires semiannual testing of Outfall 001B, the LWTP outfall, for all the priority pollutants — 124 metals and organic compounds identified by the IEPA as being of particular concern. During 2002, this sampling was conducted in June and December. Organic compound concentrations were very low. Chloroform (3 μg/L) was detected in both the June and December samples, as was bromodichloromethane (2 μg/L) and dibromochloromethane (1 μg/L). Bromoform (1 μg/L) was detected in the June sample. It is suspected that the chloroform, dibromochloromethane, bromodichloromethane and bromoform result from the contact of chlorinated water with organic chemicals and residues from cooling tower biocide treatment chemicals. All semivolatile concentrations were below the detection limits. Low concentrations of arsenic (0.003 mg/L), copper (0.017 mg/L), selenium (0.004 mg/L), silver (0.005 mg/L), and thallium (0.002 mg/L) were detected at levels below the corresponding effluent limits (see Table 5.8). Zinc (0.165 mg/L) was detected in December at a level exceeding the effluent limit. These findings are discussed further in Chapter 5.

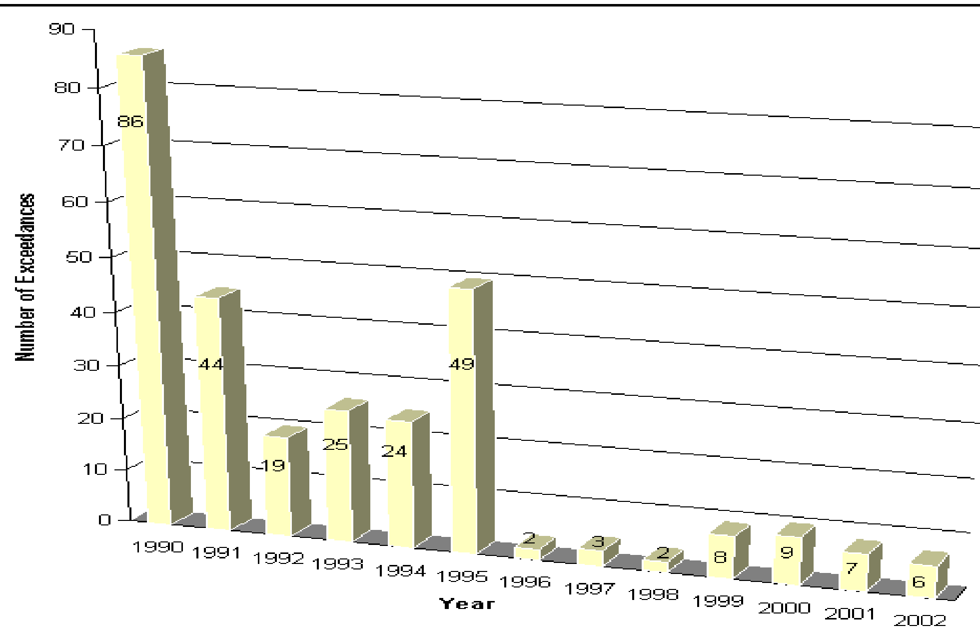


Figure 2.4 Total Number of NPDES Exceedances, 1990 to 2002

In addition to the priority pollutant analysis, the permit requires annual biological toxicity testing of the combined effluent stream, Outfall 001. This testing was conducted June 17 through June 21, 2002. The data indicate that the effluent was not acutely toxic to either the fathead minnow or the water flea. Data from the past nine years suggest that cessation of chlorination of ANL-E effluent can be correlated with a beneficial effect on aquatic life in the receiving streams.

Special Condition No. 9 of the NPDES Permit requires annual aquatic toxicity testing of Outfalls 003H, 003I, 003J, 004, 006, and 115 during the months of July and August. The samples were collected July 22 through July 26, 2002, and August 19 through 23, 2002. A review of the July data indicates that Outfalls 003H, 004, 006, and 115 exhibited no toxicity for either the water flea or the fathead minnow. Similar to results from 2001, Outfall 003I was acutely toxic to the water flea but not to the fathead minnow. Outfall 003J was acutely toxic to both the water flea and fathead minnow.

The acute toxicity observed at these outfalls is believed to be related primarily to residual chlorine levels in the domestic water, some of which is discharged to the outfalls. Chlorine levels that are necessary to protect the water distribution system are high enough to cause measurable acute toxic effects in these tests. Another source of halogen compounds identified earlier is discharged cooling water containing water treatment chemicals used in various cooling towers throughout the site. Steps are being taken to redirect these nonstorm wastewater discharges into ANL-E's sewer systems to reduce the toxicity problems at these untreated outfalls.

2.2.1.4. Storm Water Regulations

In November 1990, the EPA promulgated regulations governing the permitting and discharge of storm water from industrial sites. The ANL-E site contains a large number of small-scale operations that are considered industrial activities under these regulations and, thus, are subject to these requirements. An extensive storm water characterization and permitting program was initiated in 1991 and continues as required in present and pending NPDES Permits; ANL-E's NPDES Permit includes both industrial and stormwater discharges to surface water.

The NPDES Permit contains two special conditions requiring Storm Water Pollution Prevention Plans (SWPPPs): (1) a stand-alone plan for the APS construction site (Special Condition No. 12, which was accomplished years ago and no longer is required since the completion of APS construction, and (2) a sitewide plan for the remainder of the ANL-E site (Special Condition No. 11). Special Condition No. 11 additionally requires ANL-E to inspect and report annually on the effectiveness of the sitewide SWPPP. In 2002, the annual inspection was completed and a report was submitted to the IEPA in December 2002. Also, the Storm Water Pollution Prevention Committee (SWPPC), the ANL-E organization that performs the annual inspection, was reformed with a near complete turnover of membership. From the inspection, the SWPPC concluded that the SWPPP should undergo a complete joint review with the DOE-Argonne Area Office (AAO), and then be rewritten and reissued. This will be accomplished in spring 2003.

2.2.2. NPDES Inspections and Audits

The IEPA conducted a compliance inspection on May 16 and 17, 2002. No issues were identified.

2.2.3. General Effluent and Stream Quality Standards

In addition to specific NPDES Permit conditions, ANL-E discharges are required to comply with general effluent limits contained in 35 IAC Part 304. Also, wastewater discharges must be of sufficient quality to ensure that Sawmill Creek complies with IEPA General Use Water Quality Standards (WQSs) found in 35 IAC Part 302, Subpart B. Chapter 5 of this report, which presents the results of the routine environmental monitoring program, also describes the general effluent limits and WQSs applicable to the outfalls and discusses compliance with these standards.

2.2.4. Spill Prevention Control and Countermeasures Plan

ANL-E maintains a Spill Prevention Control and Countermeasures (SPCC) Plan as required by the CWA and EPA regulations at 40 CFR Part 112. This plan describes the planning, design features, and response measures that are in place to prevent oil or oil products from being released to navigable waters of the United States. Persons with specific duties and responsibilities in such situations are identified, as are reporting and record-keeping requirements mandated by the regulations. Regular training is conducted on implementation of this plan. No reportable spills occurred in 2002 that required activation of the SPCC Plan.

40 CFR 112.5 (b) requires that the plan undergo a complete review and evaluation at least once every three years. This was completed within the regulatory time frame, on September 24, 2001. In addition, the same regulation requires that, within six months of the evaluation, changes to the plan identified by the evaluation will be completed and implemented. The plan was rewritten and reissued March 31, 2002.

DOE/AAO participated in a joint appraisal of the SPCC in December 2002. The SPCC assessment report is pending. No issues were identified.

2.2.5. Clean Water Action Plan

The Clean Water Action Plan Program, instituted in 1998, constitutes a voluntary commitment by federal agencies to work cooperatively to improve water quality in the United States. The approach is for federal agencies to form partnerships to identify watersheds with the most critical water quality problems. The goals of the plan are to establish initiatives to reduce public health threats, improve stewardship of natural resources, strengthen control of polluted runoff, and make water quality information more accessible to the public.

No formal plans related to this initiative have been established at ANL-E. However, ANL-E has worked with the IEPA to reduce or eliminate surface water discharges of regulated pollutants. Special focus has been on exceedances of NPDES Permit parameter limits. Past upgrades to the ANL-E physical plant included acquisition of Lake Michigan water to replace dolomite well water as the source of domestic water. Lake Michigan water has a much lower TDS content than dolomite water, and the use of Lake Michigan water has reduced the amounts of TDS and copper that are discharged (water with lower TDS levels is less aggressive at dissolving copper from piping). The rehabilitation of the SWTP resulted in compliance with the ammonia-nitrogen limit. The upgrade of the LWTP also was completed, which gives ANL-E a number of options for treating various waste streams more effectively.

During 2002, ANL-E completed its efforts to direct some significant surface water discharges that contain boiler blowdown, coal pile runoff, and road salt runoff to a county wastewater treatment plant. This action appears to have reduced reoccurring TDS exceedances at the main outfall during the winter season. Additional projects to redirect the blowdown from cooling towers to the WTP to reduce total suspended solids (TSS) releases are being considered. ANL-E continues to reroute a number of sumps and drains from surface discharge to the WTP. Building 213 will be rerouted in spring 2003. These reroutes are intended to prevent discharge of chlorinated water to the environment and to eliminate violations of permit limits and aquatic toxicity test failures.

The Clean Water Action Plan includes a strategy to achieve a net increase of 100,000 wetland acres per year by 2005. ANL-E is contributing to this effort by increasing the size of an existing wetland by up to 3 ha (6 acres). This wetland restoration effort is further discussed in Section 2.13.

2.3. Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) and its implementing regulations are intended to ensure that facilities that treat, store, or dispose of hazardous waste do so in a way that protects human health and the environment. The Hazardous and Solid Waste Amendments of 1984 (HSWA) created a set of restrictions on land disposal of hazardous waste. In addition, the

HSWA also require that releases of hazardous waste or hazardous constituents from any Solid Waste Management Unit (SWMU) at a RCRA-permitted facility be remediated, regardless of when the waste was placed in the unit or whether the unit originally was intended as a waste disposal unit. The RCRA program includes regulations governing management of underground storage tanks (USTs) containing hazardous materials or petroleum products. The IEPA has been authorized to administer most aspects of the RCRA program in Illinois. The IEPA issued a RCRA Part B Permit to ANL-E and DOE on September 30, 1997. The permit became effective on November 4, 1997.

The permit has been modified eight times. Table 2.6 presents a summary of the RCRA Part B Permit modifications.

2.3.1. Hazardous Waste Generation, Storage, Treatment, and Disposal

The nature of the research activities conducted at ANL-E results in the generation of small quantities of a large number of waste chemicals. Many of these materials are classified as hazardous waste under RCRA. ANL-E has 25 Hazardous Waste Management Units; these consist of 17 container storage units and 1 tank storage unit, and 4 miscellaneous treatment units and 3 tank chemical treatment units. Table 2.7 provides descriptions of all of the units. Closure of the concrete storage pad in the 317 Area was initiated in 2002. The closure is expected to be complete in 2003. Figure 2.5 shows the locations of the major active hazardous waste treatment, storage, and disposal areas at ANL-E.

ANL-E prepares an annual Hazardous Waste Report. The report is submitted to the IEPA by March 1 of each year and describes the activity of the previous year. It is a summation of all RCRA waste activities, including generation, storage, treatment, and disposal. The report describing such activities during 2002 was submitted to the IEPA on February 21, 2003. The RCRA-permitted storage facilities, designed and operated in compliance with RCRA requirements, allow for accumulation and storage of waste pending off-site disposal. ANL-E's on-site permitted treatment facilities address a small number of hazardous wastes generated by ANL-E operations. Off-site treatment and disposal take place at approved hazardous waste treatment and disposal facilities. Hazardous wastes that were generated, disposed of, or recycled during 2002 are described in Table 2.8.

2.3.2. Hazardous Waste Treatability Studies

No hazardous waste treatability studies were conducted at ANL-E during 2002.

TABLE 2.6

Summary of Modifications to the RCRA Part B Permit

Modification Application Number	Purpose	IEPA Approval Date
1	Update the application and request a number of Class 1 modifications.	Pending
2	Allows ANL-E to accept the ash from the incineration of ANL-E generated mixed waste at the DOE-owned Waste Experimental Reduction Facility in Idaho, in the event that it can not be disposed of otherwise.	February 8, 1999
3	(1) Allows use of Building 303 to store surplus chemicals; (2) updates the operating procedures for the Building 308 Alkali Metal Passivation Booth, and (3) updates the RCRA Contingency Plan.	August 8, 2000
4	One Class 1 Modification and one Class 2 Modification allow ANL-E to (1) change the name of the DOE signatory authorized to sign documents related to the ANL-E RCRA Part B Permit, and (2) use a concrete pad at Building 331 for the storage of solid radioactive and mixed waste.	January 12, 2001
5	Class 1 Modification allows ANL-E to update the RCRA Contingency Plan.	February 12, 2001
6	Class 1 Modification allows ANL-E to change the name of the ANL-E signatory authorized to sign documents related to the ANL-E RCRA Part B Permit.	March 1, 2002
7	(1) Update the RCRA Contingency Plan, and (2) allow ANL-E to receive seven drums of defense contact-handled mixed transuranic waste from the Missouri University Research Reactor facility in Columbia, Missouri. At ANL-E, the drums will be characterized and certified for disposal and shipped to the Waste Isolation Pilot Plant located in Carlsbad, New Mexico.	November 18, 2002
8	Approve design and equipment changes to the permitted Building 306 Metal Precipitation/Filtration Treatment Unit.	November 18, 2002

TABLE 2.7

Permitted Hazardous Waste Treatment and Storage Facilities, 2002

Description	Location	Purpose
Storage		
Concrete Storage Pad	317 Area[a] Building 331	Storage of solid radioactive waste and solid mixed waste (MW) in the form of steel-encased lead shielding containers and containerized solid MW.
Container Storage Area	Building 325C, East	Storage of liquid and solid bulk or lab-packed flammable and reactive hazardous waste and solid and liquid bulk polychlorinated biphenyls (PCBs) and miscellaneous PCB units.
	Building 325C, West	Storage of bulk and lab-packed liquid flammable hazardous waste.
	Building 303 Mixed Waste Storage Facility	Storage of containers of ignitable, corrosive, oxidizing, reactive, and solid hazardous, radiological, or MW.
	Building 331 Radioactive Waste Storage Facility	Storage of containers of flammable, toxic, corrosive, and oxidizing hazardous, radiological, and MW.
Dry Mixed Waste Storage Area	Building 374A	Storage of solid MW and radioactively contaminated lead bricks.
Mixed Waste Container Storage	Building 329	Storage of containers of bulk and lab-packed ignitable MW or compatible waste.
Portable Storage Units (4)	Building 306	Storage of hazardous, radiological, or MW (3 of 4 units).
		Bulking operations to consolidate and reduce the volume of lab-packed waste in containers (1 of 4 units).
Hazardous Waste Storage Facility[b]	Building 307	Proposed storage facility for hazardous waste

TABLE 2.7 (Cont.)

Description	Location	Purpose
Tank Storage	Building 306	Storage of corrosive and toxic mixed waste and radiological liquid wastes (4,000 gal; currently not used).
Mixed Waste Storage	Building 306 - Storage Room A-142	Storage of ignitable MW.
	Building 306 - Storage Room A-150	Storage of solid and liquid MW.
	Building 306 - Storage Room C-131	Storage of ignitable, corrosive, and reactive hazardous waste.
	Building 306 - Storage Room C-157	Storage of corrosive and oxidizer MW.
	Building 306 - Storage Room D-001	Storage of solid MW containing toxic metal constituents.
Treatment		
Alkali Metal Passivation Booth	Building 206	Destruction of water reactive alkali metals possibly contaminated with radionuclides.
Alkali Metal Passivation Booth	Building 308	Destruction of water reactive alkali metals.
Chemical/Photooxidation Unit	Building 306	Treatment of ignitable liquid MW containing organic contaminants.
Dry Ice Pellet Decontamination Unit	317 Area	Treatment of solid MW having radionuclide and/or RCRA metal surface contamination.
Low-Level Radioactive Waste (LLW) Neutralization/Precipitation System	Building 306	Treatment of aqueous, corrosive LLW, some of which is contaminated with heavy metals.
Mixed Waste Immobilization/ Macroencapsulation Unit	Building 306	Treatment of solid, semisolid, and organic liquid MW containing RCRA metals.
Transuranic (TRU) Neutralization/Precipitation Treatment Unit	Building 306	Treatment of corrosive, aqueous MW containing TRU radionuclides and RCRA metals.

[a] Closure of this facility was initiated in 2002.

[b] This facility is permitted. However, it has not yet been built.

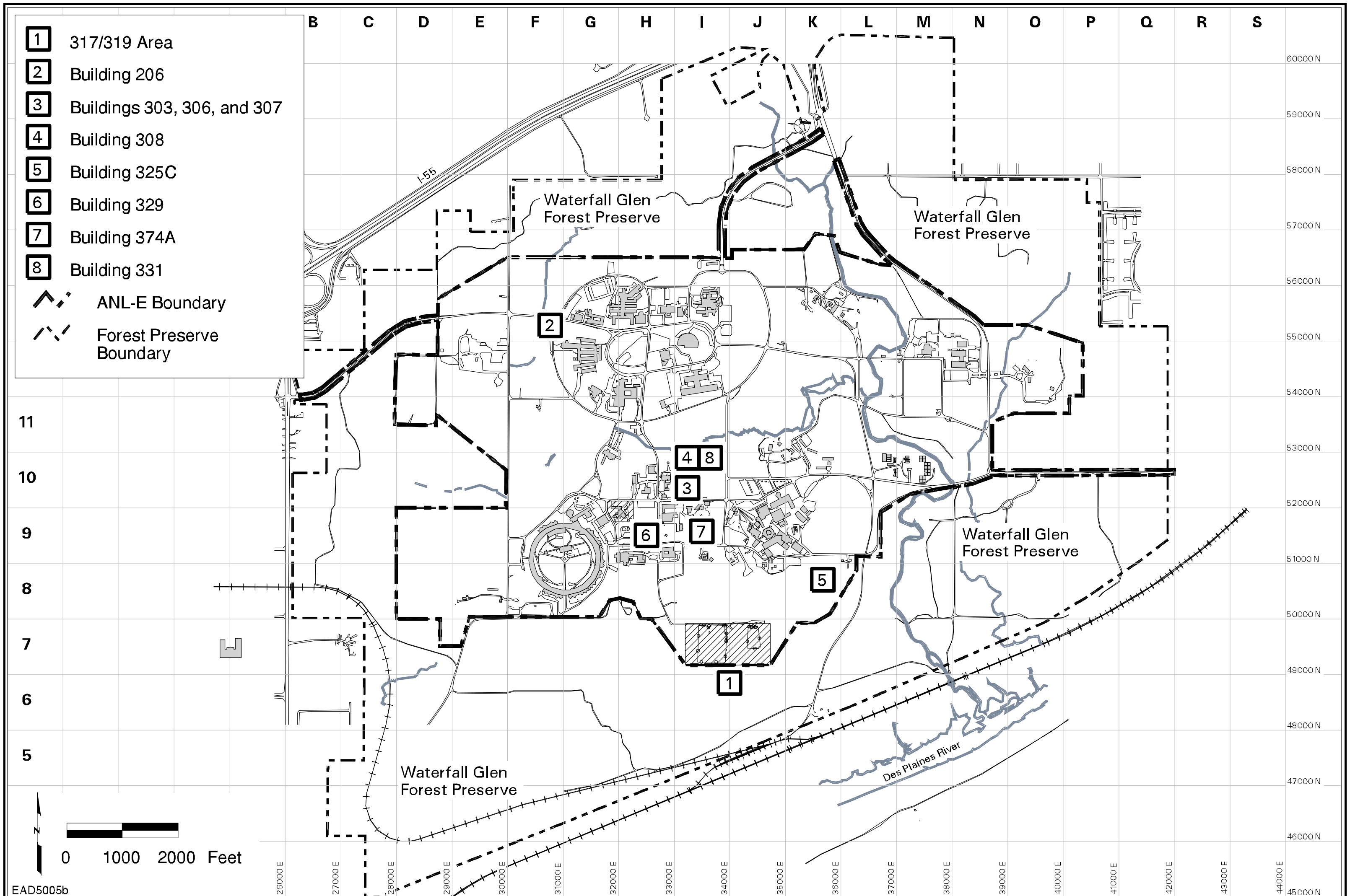


Figure 2.5 Major Treatment, Storage, and/or Disposal Areas at ANL-E

TABLE 2.8

Hazardous Waste Generation, Treatment, Disposal, or Recycle, 2002

Waste	Volume (gal)[a]	Weight (lb)
Generated and Disposed of or Recycled		
Acidic cleaning solutions	390	3,510
Aerosol cans	115	575
Alkaline cleaning solution with mercury	30	210
Aqueous solutions with sodium nitrate	110	918
Aqueous solutions with zinc	30	252
Brake cleaner fluid[b]	7	57
Bulked laboratory solvents	440	3,080
Calcium hypochlorite-chloride waste	30	100
Carbon-waste	115	460
Caustic waste solutions	220	1,848
Compressed gases	210	1,050
Cutting oils with lead and solvents	110	792
Heavy metal-contaminated soil	195	780
Immersion cleaner fluid[b]	18	148
Labpacks of liquid chemicals	1,634	13,075
Labpacks of solid chemicals	986	3,943
Lead-waste articles	110	800
Lead-contaminated debris	855	3,420
Mercury- and sodium-contaminated debris	220	1,500
Oil-based paint waste	30	300
Paint and solvent-containing debris	115	460
Plating wastes containing lead	220	2,002
Solvent-containing debris	195	780
Used oil[b]	1,570	3,600
Universal Hazardous Waste		
Mercury-containing lamps[b]	7,360	7,360
Lead acid batteries[b]	400	6,500

[a] In accordance with RCRA regulations, waste amounts are reported in units of gallons, regardless of the physical form of the waste.

[b] Recycled waste.

2.3.3. Mixed Waste Generation, Storage, Treatment, and Disposal

A small number of hazardous wastes that ANL-E generates also exhibit radioactivity, thereby making them "mixed waste." The hazardous component of mixed waste is subject to RCRA regulations, while the radioactive component is subject to regulation under the Atomic Energy Act of 1954 (AEA) as implemented by DOE Orders. Accordingly, facilities storing or disposing of mixed waste must comply with both DOE requirements and RCRA permitting and facility standards. ANL-E generates several types of mixed waste, including acids, solvents, and sludges contaminated with radionuclides. The RCRA Part B Permit provides for on-site treatment in five mixed waste treatment systems. These systems include neutralization of low-level radioactive waste (LLW) and transuranic (TRU) corrosive aqueous waste and the stabilization of sludge and soil. In addition, during 2002, some of the mixed waste was sent off site to Envirocare of Utah, Inc., a commercial treatment and disposal facility. Table 2.9 lists the mixed waste generated, stored, treated on site, or shipped off site for disposal in 2002.

2.3.4. Federal Facility Compliance Act Activities

The Federal Facility Compliance Act of 1992 (FFCA) amended RCRA to clarify the application of its requirements and sanctions to federal facilities. The FFCA also requires that DOE prepare mixed waste treatment plans for DOE facilities that store or generate mixed waste. The Proposed Site Treatment Plan (PSTP) for mixed waste generated at ANL-E was submitted to the IEPA and the Illinois Department of Nuclear Safety (IDNS) in March 1995. Mixed waste at ANL-E has been managed in accordance with the PSTP since October 1995. ANL-E's RCRA Part B Permit provides for on-site treatment of certain mixed waste as required by the PSTP.

During 2002, ANL-E completed the treatment milestones for waste streams that included metal wastes, inorganic solids with cadmium, and combustible solids with metals.

In 2003, ANL-E will be working on completing treatment of several lower-volume waste streams. Complete treatment of all stored mixed waste is expected by September 2005. Twelve mixed waste streams will be treated under the PSTP; six will be treated by September 2003, four will be treated by September 2004, and the remaining two will be treated by September 2005.

2.3.5. RCRA Inspections: Hazardous Waste

A RCRA Compliance Inspection was conducted by EPA Region V on August 21 and 22, 2002. EPA Region V reviewed pertinent documentation, such as inspection records; the contingency, waste analysis, and closure plans; and annual reports. All permitted storage and treatment units were

TABLE 2.9

Mixed Waste Generation, Treatment, Storage, and Disposal, 2002

Waste	Volume (gal)	Weight (lb)
Generated		
MW acidic solutions	291	2,910
MW acidic solutions with heavy metals	232	2,088
MW alkali metals	21	168
MW aqueous solutions with heavy metals	240	2,160
MW cyanide solution	5	42
MW elemental mercury	31	279
MW flammable liquids	81	810
MW metal scrap with cadmium	1,408	28,160
MW debris with chromium	7	177
MW debris with heavy metals	376	1,504
MW lead articles	1,236	111,240
MW sludge with heavy metals	250	2,500
MW soil with heavy metals	692	6,228
MW uranyl nitrate	8	160
TRU acids with heavy metals	90	810
TRU debris with heavy metals	1,228	4,912
Shipped for Treatment/Disposal		
MW debris with chromium	60	1,500
MW debris with heavy metals	2,675	10,700
MW lead articles	1,124	101,160
MW metal scrap with cadmium	3,423	68,460
MW metal scrap with heavy metals	2,679	80,730
Treated		
MW acidic solutions with heavy metals	10	90
MW acidic solutions	176	1,760
MW aqueous solutions with heavy metals	473	4,256
MW soil with heavy metals	210	1,890
In Storage		
MW acidic solutions	336	3,026
MW acidic solutions with heavy metals	573	5,161

TABLE 2.9 (Cont.)

Waste	Volume (gal)	Weight (lb)
MW alkali metals	170	1,359
MW aqueous solutions with heavy metals	240	2,160
MW cyanide solution	36	301
MW elemental mercury	58	522
MW flammable liquids	162	1,620
MW uranyl nitrate	270	5,392
MW metal scrap with cadmium	55	1,100
MW metal scrap with heavy metals	110	3,300
MW debris with chromium	16	400
MW debris with heavy metals	33	131
MW debris with volatile organics	171	684
MW lead articles	4,321	388,917
MW sludges with heavy metals	800	8,000
MW soil with heavy metals	891	8,915
TRU acids	147	1,325
TRU cadmium	138	9,913
TRU debris with heavy metals	17,770	71,080
TRU lead	170	15,306
TRU sludge	37	375

inspected. The EPA determined that ANL-E provided an exemplary waste management program and is in compliance with RCRA regulations.

2.3.6. Underground Storage Tanks

The ANL-E site currently contains 17 USTs. Seven of the existing tanks are being used to store fuel oil for emergency generators. The on-site vehicle fueling and maintenance facilities (Building 46 and the on-site service station) use underground tanks to store diesel, gasoline, used oil, antifreeze, and ethanol/gasoline blend. The 2,100-L (550-gal) UST at Building 368 that was used to store diesel fuel was removed in December 2002.

2.3.7. Corrective Action for Solid Waste Management Units

As mentioned previously, the HSWA require that any RCRA Part B Permit issued must include provisions for corrective action to address releases of hazardous constituents from any SWMU at the site, regardless of when waste was placed in the unit. Accordingly, the ANL-E Part B Permit issued in September 1997 contains procedures and requirements to govern the corrective action of such units. The Part B Permit identifies 49 SWMUs and 6 Areas of Concern (AOCs). One of the AOCs, AOC-I (Sediments near the East-Northeast [ENE] Landfill), was added by the IEPA in December 2002. During 2002, ANL-E submitted requests for No Further Action (NFA) for 8 SWMUs; the IEPA approved 5 ANL-E NFA requests. These SWMUs are listed in Table 2.10. As of December 2002, the IEPA has approved NFA for 38 SWMUs. The remediation program for the remaining units will continue under the authority of the Part B Permit. Chapter 3 of this report contains a summary of the characterization and remediation activities currently underway at a number of the SWMUs in accordance with IEPA-approved corrective action work plans.

TABLE 2.10

No Further Action Requests and Approvals, 2002

SWMU Number	SWMU Name
7[a]	Freund Ponds
104[a]	Laboratory Retention Tank (Building 310)
105[a]	Laboratory Retention Tank (Building 310)
106[a]	Laboratory Retention Tank (Building 310)
150[a]	Building 34 – Liquid Mixed Waste Treatment
179[a]	Storm Sewers – Cooling Tower Wastewater
721[a]	Retention Tank Sumps (Building 310)
744[a]	Newly Identified Suspected Solid Waste Landfill
136[b]	570 Area – Sanitary Wastewater Sludge Drying Beds
146[b]	A^2R^2 Reactor Excavation Fill
179[b]	Storm Water – Cooling Tower Wastewater
180[b]	Scrap Disposal Staging Area East of 377 Cooling Towers
AOC-H[b]	Contaminated Soil near Former Building 24

[a] NFA request to IEPA in 2002.

[b] IEPA approved NFA in 2002.

2.4. Solid Waste Disposal

In September 1992, ANL-E ceased operation of its 800 Area Landfill, which had begun operating in 1966. The IEPA issued the original operating permit in 1981 in accordance with 35 IAC Part 807. Supplemental permits addressing final elevations, a groundwater monitoring program, and closure/postclosure requirements, such as gas monitoring, were issued by the IEPA on April 24, 1992; September 15, 1992; January 11, 1995; November 20, 1997; August 25, 1998; September 16, 1998; June 16, 1999; April 25, 2000; and October 1, 2002. Groundwater Quality Standards of some routine indicator parameters have been consistently exceeded. Exceedances occur primarily in shallow, perched pockets of groundwater in the glacial drift that is not in direct communication with the deeper dolomite bedrock aquifer. To aid in the determination of the nature and extent of these exceedances, in 1999, additional groundwater monitoring wells were installed around the landfill. Hydrogen-3 has been noted in several wells at the 800 Area Landfill. The groundwater monitoring program is discussed in detail in Section 6.3.

ANL-E generates a large volume and variety of nonhazardous special wastes. Some otherwise special waste, such as sanitary sewage sludge, is certified to the IEPA as "nonspecial waste" pursuant to IEPA regulations. Table 2.11 gives the nonhazardous special and nonspecial wastes generated, stored, disposed of, or recycled during 2002. All nonhazardous special and nonspecial wastes generated at ANL-E in 2002 were disposed of at permitted off-site special waste landfills. The IEPA began requiring annual nonhazardous special waste reporting in 1991. The report is required to be submitted by February 1 of each year to describe the activity of the previous year. It is a summation of all manifested nonhazardous and polychlorinated biphenyl (PCB) wastes shipped out of state.

ANL-E also periodically generates radioactive waste containing other regulated but nonhazardous materials, such as PCBs. Table 2.11 lists the quantities of such waste stored on site or disposed of off site.

2.5. National Environmental Policy Act

The National Environmental Policy Act of 1969 (NEPA) established a national environmental policy that promotes consideration of environmental factors in federal or federally sponsored projects. NEPA requires that the environmental impacts of proposed actions with potentially significant effects be considered in an Environmental Assessment (EA) or Environmental Impact Statement (EIS). DOE has promulgated regulations in Title 10, Part 1021 of the *Code of Federal Regulations* (CFR) that list classes of actions that ordinarily require those levels of documentation or that are categorically excluded from further NEPA review. No EISs were prepared during 2002. One EA was started in 2002 for the enhanced operations at the APS, including the

TABLE 2.11

Generation, Storage, Disposal, or Recycling of Special and Nonspecial Waste, 2002

Waste	Volume	Weight (lb)
Nonhazardous Special Waste Disposal		
Contaminated soil (remediation waste)	11,820 yd^3	23,640,000
Medical waste	172 ft^3	723
Nonhazardous liquid chemicals	3,500 gal	24,669
Nonhazardous solid chemicals	3,400 gal	19,436
Petroleum naptha[a] (parts washers)	1,012 gal	6,779
Potassium chloride solution	500 gal	4,565
Used oil[a]	3,900 gal	28,080
Certified Nonspecial Waste Disposal		
Nonspecial fly ash	1,390 yd^3	1,174,138
Nonspecial laboratory sewage sludge	120 yd^3	240,000
Nonspecial sandblasting waste	15 yd^3	30,000
Nonspecial sandblast media	15 yd^3	30
Nonspecial metal debris	8 yd^3	8,000
Nonspecial contaminated soil	45 yd^3	90,000
Toxic Substances Control Act (TSCA) Special Waste Disposal		
Asbestos	240 yd^3	240,000
PCBs	995 gal	6,560
Materials Recycled		
Compressed gases[a]	74 gal	348
Diesel fuel[a]	8,550 gal	59,850
MW lead[a]	1,317 gal	20,404
Sanitary sewage sludge[a]	28,760 gal	240,000
TSCA Mixed Waste Generated		
Radioactive PCB sludge and debris	1 gal	9
TSCA Mixed Waste in Storage		
Radioactive PCB sludge and debris	57 gal	505
Radioactive PCB articles	25 gal	220

[a] Recycled waste.

conduct of Biosafety Level-3 research, and construction and operation of a Center for Nanoscale Materials and a Structural Genomics Facility.

2.6. Safe Drinking Water Act

The Safe Drinking Water Act of 1974 (SDWA) established a program to ensure that public drinking water supplies are free of potentially harmful materials. This mandate is carried out through the institution of national drinking water quality standards, such as Maximum Contaminant Levels and Maximum Contaminant Level Goals, as well as through the imposition of wellhead protection requirements, monitoring requirements, treatment standards, and regulation of underground injection activities. The regulations implementing the SDWA in 40 CFR Parts 141–143 establish Primary and Secondary National Drinking Water Regulations that set forth requirements to protect human health (primary standards) and provide aesthetically acceptable water (secondary standards).

2.6.1. Applicability to ANL-E

In January 1997, ANL-E incorporated Lake Michigan water as its domestic source water, thereby replacing the dolomite groundwater that formerly constituted its source of drinking water. The Lake Michigan water is purchased from the DuPage County Water Commission. As such, ANL-E is now a customer rather than a supplier of water. Consequently, on January 23, 1997, the DuPage County Health Department (DPCHD) notified DOE that the federal and state monitoring requirements applicable to a “non-transient, non-community” public water supply, which ANL-E had been required to satisfy while operating the on-site water supply system, no longer were applicable. In addition, sampling, analysis, and reporting of the drinking water data to the DPCHD and the Illinois Department of Health (IDPH) no longer were required. Nevertheless, ANL-E voluntarily provides to on-site personnel the Consumer Confidence Report on drinking water quality that ANL-E receives as a customer of the DuPage County Water Commission.

2.6.2. Water Supply Monitoring

During 2002, ANL-E continued an informational monitoring program at the previously used dolomite domestic wells; quarterly samples were analyzed for radionuclides and VOCs. No radionuclides or VOCs were detected.

2.7. Federal Insecticide, Fungicide, and Rodenticide Act

During 2002, all exterior pesticides and herbicides at ANL-E were applied by a licensed contractor who provides the chemicals used and removes any unused portions. ANL-E coordinates the contractor's activities and ensures that the chemicals are EPA-approved, that they are used properly, and that any unused residue is removed from the site by the contractor.

In addition, routine applications of pesticides are performed within buildings, as needed. Indoor pesticide applications are provided by IDPH-licensed contractors under the direction of Plant Facilities and Services (PFS)-Custodial Services or on-site contractors, depending on the building involved. The indoor applications involve EPA "Restricted Use" products.

In 2002, approximately 6,118 L (1,620 gal) of commercial-grade herbicide and 1,330 L (350 gal) of pesticide were applied throughout the ANL-E site. Fertilizer with weed control is included in the quantity of herbicide.

2.8. Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) addresses the cleanup of hazardous waste disposal sites and the response to hazardous substance spills. Under CERCLA, the EPA collects site data regarding sites subject to CERCLA action through generation of a Preliminary Assessment (PA) report, followed up by a Site Screening Investigation (SSI). Sites then are ranked, on the basis of the data collected, according to their potential for affecting human health or causing environmental damage. The sites with the highest rankings are placed on the National Priority List (NPL) and are subject to mandatory cleanup actions. No ANL-E sites are included in the NPL.

On December 21, 1999, the EPA published interim guidance redefining "Federally permitted releases" under CERCLA. This action may have a significant impact on ANL-E with respect to what types of air emissions will need to be reported under Section 101(10)(H) of CERCLA. The guidance provides an extremely narrow definition of how CERCLA substances released to the air would be exempted from reporting as a federally permitted release. To date, the EPA has announced it would hold implementation of the guidance in abeyance until the guidance is revised.

2.8.1. CERCLA Program at ANL-E

In early 1990, the EPA requested that DOE submit SSI reports for 6 of 13 ANL-E sites for which PA reports previously had been submitted. Upon further discussions between the EPA and DOE, one of the six sites was eliminated from consideration, and three adjacent units (317/319/East-Northeast [ENE]) were treated as a single site. As a result, three SSI reports were submitted to the EPA in January 1991. Table 2.12 lists the sites for which a PA report was submitted. As indicated in the table, these sites have either been cleaned up, are currently undergoing corrective action, or have been permitted.

2.8.2. CERCLA Remedial Actions

Remedial actions to clean up any release of hazardous materials from inactive waste sites follow one of two main routes. The first is through the CERCLA program (more commonly known as Superfund cleanup projects) and is generally used for abandoned sites. The second route is the RCRA corrective action process, which frequently is used for waste sites on active facilities. SWMUs are the units subject to RCRA corrective action. All but one of the sites described in the SSI reports (see Table 2.12) are on the ANL-E site, and most are included as SWMUs in the RCRA Part B Permit. The RCRA Part B Permit, effective November 4, 1997, contains procedures and requirements that govern the corrective action of these sites. Therefore, the remediation of the listed units that are also SWMUs will occur under the RCRA Program, not CERCLA. As of the end of 2002, corrective actions were underway or had been completed on all of the on-site units described in the CERCLA document, through the corrective action program, voluntary cleanup, or the RCRA closure process for permitted units. Sections 2.3.7 and 3.1.1 of this report contain a discussion of the RCRA corrective actions program. The cleanup of the CP-5 reactor was completed as part of the ANL-E decontamination and decommissioning (D&D) program under the oversight of DOE.

2.8.3. Emergency Planning and Community Right to Know Act (Superfund Amendments and Reauthorization Act, Title III)

Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA) amendments to CERCLA is the Emergency Planning and Community Right to Know Act (EPCRA), a free-standing provision. EPCRA requires providing federal, state, and local emergency planning authorities information regarding the presence and storage of hazardous substances and their planned and unplanned environmental releases, including providing response to emergency situations involving hazardous materials. Under EPCRA, ANL-E has been required to submit reports pursuant to Sections 302, 304, 311, 312, and 313, which are discussed below. Table 2.13 gives ANL-E's status in regard to EPCRA.

TABLE 2.12

List of Inactive Waste Disposal Sites at ANL-E
Described in Various CERCLA Reports

Site Name
On Current ANL-E Property
319 Area Landfill and French Drain[a,b,c]
800 Area Landfill and French Drain[a,b,c]
810 Area Paint Shop[d]
Compressed Gas Cylinder Disposal Area, 318 Area[a,b,c]
Decommissioned Reactor CP-5, Building 330[a,b]
French Drain, 317 Area[a,b,c]
Gasoline Spill, Gasoline Station[e]
Landfill East-Northeast of the 319 Area[a,b,c]
Liquid Waste Treatment Facility, Building 34[b,f]
Mixed Waste Storage, 317 Area[a,g]
Shock Treatment Facility, 317 Area[a,c]
Wastewater Holding Basin, Sewage Treatment Plant[b,g]
On Former ANL-E Property, Currently Waterfall Glen Forest Preserve
Reactive Waste Disposal, Underwriters Pond[h]

[a] SSI report submitted to the EPA in 1991.

[b] RCRA SWMU.

[c] RCRA corrective action completed.

[d] Contaminated soil removed.

[e] Remediation completed.

[f] Currently undergoing closure.

[g] Permitted under RCRA.

[h] Will be addressed in future investigations.

TABLE 2.13

Status of EPCRA Reporting, 2002

EPCRA Section	Description of Reporting	Status
Section 302	Planning notification	Yes
Section 304	EHS release notification	Not required in 2002
Section 311–312	Material Safety Data Sheet (MSDS) chemical inventory	Yes
Section 313	Toxic Release Inventory (TRI) reporting	Yes

Section 302 of SARA Title III, Planning Notification, addresses notifying and updating the Local Emergency Planning Committee (LEPC) and the State Emergency Response Commission as to the presence of extremely hazardous substances (EHSs) at ANL-E, including laboratory usage, that exceed any EHS threshold planning quantity.

Section 304 of SARA Title III, Extremely Hazardous Substances Release Notification, requires that the LEPC and state emergency management agencies be notified of accidental or unplanned releases of Section 302 hazardous substances to the environment. Also, the National Response Center is notified if a release exceeds the CERCLA Reportable Quantity for that particular hazardous substance. The procedures for notification are described in the ANL-E Comprehensive Emergency Management Plan. There were no incidents requiring notification during 2002.

Under SARA Title III, Section 311, Material Data Safety Sheet (MSDS)/Chemical Inventory, ANL-E is required to provide applicable emergency response agencies with MSDSs, or a list of MSDSs, for each hazardous chemical stored on site. The application information was sent to DOE on December 6, 2002, for subsequent transmittal to the DuPage County LEPC and the Illinois Emergency Management Agency.

Pursuant to EPCRA Section 312, ANL-E is required to report certain information regarding inventories and the locations of hazardous chemicals to state and local emergency authorities upon request. Petroleum products need to be reported. However, chemicals used in research laboratories under the direct supervision of a technically qualified individual are exempt from reporting. The report on Section 312 information for 2002 was provided to DOE on February 26, 2003. Table 2.14 lists the hazardous chemicals reported.

Section 313 of SARA Title III, Toxic Release Inventory (TRI) Reporting, requires facilities to prepare an annual report entitled “Toxic Chemical Release Inventory, Form R” if annual usage of listed toxic chemicals exceed certain thresholds. ANL-E is not within the range of Standard Industrial Codes specified in the statute. ANL-E reports this information, however, because DOE,

TABLE 2.14

ANL-E, SARA, Title III, Section 312, Chemical List, 2002

Compound	Physical Hazard: Fire	Physical Hazard: Pressure	Physical Hazard: Reactivity	Health Hazard: Acute	Health Hazard: Chronic
Ethanol/gasoline	X	-[a]	-	X	-
Aluminum sulfate	-	-	-	X	-
Chlorodifluoromethane	-	-	-	-	X
Diesel fuel/heating oil	X	-	-	-	-
Gasoline	X	-	-	X	-
Methanol/gasoline	X	-	-	X	-
NALCO 356 amine corrosion inhibitor	X	-	-	X	-
Sulfuric acid	-	-	-	X	-
Trichlorofluoromethane	-	-	-	-	X

[a] A hyphen indicates that the compound does not fall within the particular hazard class.

which is subject to Executive Order 13148, “Greening the Government through Leadership in Environmental Management” (April 21, 2000), directs ANL-E to do so. No reports were filed from 1997 to 2000, because no listed chemicals usage exceeded reporting thresholds. However, new requirements regarding a class of TRI compounds called persistent, bioaccumulative toxics (PBTs) came into effect in 2000. As a result, ANL-E filed two reports under Section 313 in 2002 for activities in 2001 for lead and chlorodifluoromethane (HCFC-22). Use of lead included machining of various types of lead articles in excess of the 45-kg (100-lb) reporting threshold. Use of HCFC-22 for charging a number of cooling systems exceeded 4,500 kg (10,000 lb) for the year and therefore was subject to reporting.

2.9. Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) was enacted to require chemical manufacturers and processors to develop adequate data on the health and environmental effects of their chemical substances. The EPA has promulgated regulations to implement the provisions of TSCA. These regulations are found in CFR Title 40, “Protection of the Environment, Chapter I: Environmental Protection Agency, Subchapter R - Toxic Substances Control Act.” These regulations provide specific authorizations and prohibitions on the manufacturing, processing, and distribution in commerce of designated chemicals. The principal impact of these regulations at the ANL-E site concerns the handling of asbestos and PCBs. Suspect PCB-containing items that are subject to this act are identified through the ANL-E PCB Item Inventory Program.

DOE-AAO and ANL-E conducted a joint appraisal of the ANL-E TSCA compliance program in July and August 2002. The TSCA assessment report, completed October 2002, identified two Improvement Opportunities. Corrective actions are currently being completed.

2.9.1. PCBs in Use at ANL-E

PCB items in use or in storage for reuse are tracked by the ANL-E PCB Item Inventory Program. All PCB items identified by the PCB Item Inventory Program have been labeled appropriately with a unique number for inventory and tracking purposes. These items are included in the ANL-E Annual PCB Report, which describes the location, quantity, manufacturer, and unique identification number for all PCBs on site. The PCBs in use at ANL-E are contained in capacitators and power supplies. Waste Management Operations (WMO) processes PCB-contaminated equipment and oil for disposal. The regulations governing the use and disposal of PCBs can be found in 40 CFR Part 761. This report is not submitted to regulatory agencies but is kept on file at ANL-E. The Annual PCB Report for 2002 was completed on June 18, 2003.

2.9.2. Disposal of PCBs

Disposal of PCBs from ANL-E operations includes materials lab-packed and bulked and aggregated solids shipped off site through WMO. This includes PCB-containing materials that also contain radioactive substances, known as TSCA mixed waste. Table 2.11 contains the amount of PCBs and PCB-contaminated materials and TSCA mixed waste in storage and shipped by ANL-E during 2002.

Several years ago, contamination from historical PCB spills resulted in the generation of sludge contaminated by both PCBs and low-level radioactivity from the building retention tanks and holding tanks at the laboratory WTP. During 2002, no radioactive PCB-contaminated sludge and debris were shipped off site for disposal. Radioactive PCB-contaminated sludge, debris, or articles in storage totaled 314 L (82 gal).

2.10. Endangered Species Act

The Endangered Species Act of 1973 (ESA) is federal legislation designed to protect plant and animal resources from the adverse effects of development. Under the Act, the Secretaries of the Interior and Commerce are directed to establish programs to ensure the conservation of endangered or threatened species and the critical habitat of such species. The USFWS has been delegated authority to implement the requirements of the ESA.

To comply with the ESA, federal agencies are required to assess the area of a proposed project to determine whether it contains any threatened or endangered species, or critical habitat of such species. If such species or habitat are found to exist, the USFWS would be consulted.

At ANL-E, the applicable requirements of the ESA are identified and satisfied through the NEPA project review process. All proposed projects must provide a statement describing the potential impact to threatened or endangered species and critical habitat. This statement is included in the general Environmental Review Form. If the potential exists for an adverse impact, this impact will be assessed further and will be evaluated through consultation with the USFWS, and, if necessary, the preparation of a more detailed NEPA document, such as an EA or EIS. Where appropriate, this information is shared with affected state and federal stakeholders, so that potential adverse impacts are assessed fully and any steps to minimize these impacts can be identified.

No federal-listed threatened or endangered species are known to occur on the ANL-E site, and no critical habitat of federal-listed species exists on the site. Three federal-listed endangered species and one federal-listed species are known to inhabit the Waterfall Glen Forest Preserve that surrounds the ANL-E property, or to occur elsewhere in the area.

The Hine's emerald dragonfly (*Somatochlora hineana*), federal and state listed as endangered, occurs in locations with calcareous seeps and wetlands along the Des Plaines River floodplain. Leafy prairie clover (*Dalea foliosa*), which is federally and state listed as endangered, is associated with dolomite prairie remnants of the Des Plaines River valley; two planted populations of this species occur in Waterfall Glen Forest Preserve. An unconfirmed capture of an Indiana bat (*Myotis sodalis*), which is federal and state listed as endangered, indicates that this species may occur in the area. The federal-listed threatened lakeside daisy (*Hymenoxys herbacea*) has a planted population in Waterfall Glen Forest Preserve.

Although state-listed species that occur in the area are not covered by the ESA, the following state-listed species are evaluated in the NEPA process:

- Endangered
  - Black-crowned night heron (*Nycticorax nycticorax*)
  - Glade quillwort (*Isoetes butleri*)
  - Osprey (*Pandion haliaetus*)
  - Shadbush (*Amelanchier interior)*
  - Tuckermans sedge (*Carex tuckermanii*)

- Threatened
  - Blandings turtle (*Emydoidea blandingii*)
  - Brown creeper (*Certhia americana*)
  - Hills thistle (*Cirsium hillii*)

– Kirtland's snake (*Clonophis kirtlandii*)
– Marsh speedwell (*Veronica scutellata*)
– Pied-billed grebe (*Podilymbus podiceps*)
– Red-shouldered hawk (*Buteo lineatus*)
– River otter (*Lutra canadensis*)
– Slender sandwort (*Arenaria patula*)
– White lady's slipper (*Cypripedium candidum*)

Of these, Kirtland's snake, pied-billed grebe, black-crowned night heron, red-shouldered hawk, and brown creeper have been observed on ANL-E property. Impacts to these species also would be assessed during the NEPA process.

2.11. National Historic Preservation Act

The National Historic Preservation Act (NHPA) requires federal agencies to assess the impact of proposed projects on historic or culturally important sites, structures, or objects within the sites of proposed projects. It further requires federal agencies to assess all sites, buildings, and objects on such sites to determine whether any qualify for inclusion in the NRHP. The Act also requires federal agencies to consult with the Illinois Historic Preservation Agency (IHPA) and the Advisory Council on Historic Preservation, as appropriate, when proposed actions would adversely affect properties that are eligible for listing on the NRHP.

The NHPA is implemented at ANL-E through the NEPA review process, as well as through the ANL-E digging permit process. All proposed actions must consider the potential impact to historic or culturally important artifacts and document this consideration on the Environmental Review Form. If the proposed site has not been surveyed for the presence of such artifacts, a cultural resources survey is conducted, and any artifacts found are documented and removed carefully. Prior to disturbing the soil, an ANL-E digging permit must be obtained from the PFS Division. This permit must be signed by the designated permit reviewer after verifying the location of nearby archaeological sites and documenting the fact that no significant cultural resources would be affected. DOE consults with the IHPA and the Advisory Council on Historic Preservation, as appropriate, if proposed actions would adversely affect properties eligible for listing on the NRHP.

In fall 2001, DOE entered into a programmatic agreement with the IHPA and the Advisory Council on Historic Preservation for management of cultural resources at ANL-E. This agreement streamlines compliance with the NHPA by allowing standard mitigation measures and by excluding from Section 106 review certain categories of activities that are unlikely to adversely affect historic structures.

Work on a Cultural Resources Management Plan (CRMP) that will replace the programmatic agreement is continuing. DOE expects to have a draft available for public review in late 2003.

Cultural resources include both historic structures and archaeological sites. Phase I archaeological surveys have been completed for the entire ANL-E facility, and 46 archaeological sites have been recorded. Of these, 23 sites have been tested to determine eligibility for inclusion on the NRHP. Four of the 23 sites tested potentially are eligible for the NRHP. Twenty-one sites have been determined to be ineligible, and 21 recorded sites have not yet been formally evaluated for eligibility.

In fall 2001, Argonne completed a two-phased Sitewide Historic Property Inventory for ANL-E. The historic context portions of this inventory add significantly to the nuclear energy and nuclear science portions of the DOE Cold War story. On the basis of inventory reports, DOE determined that two areas — the Main Campus District and the Freund Estate District — are eligible for listing on the NRHP as historic districts and that five buildings are individually eligible for listing on the NRHP.

The Main Campus district includes six scientific buildings: 200, 202, 203, 205, 206, and 211. These buildings were identified on the basis of their contribution in association with advancements in nuclear research and the development of nuclear power reactors (Criterion A) and for their engineering and design value as a unique specialized and cohesive scientific facility (Criterion C). The Freund Estate district includes five facilities: the former Freund Lodge (Building 600), the pool (603), bathhouse (604), pavilion (606), and tennis courts (616). All are eligible for listing under Criterion B, on the basis of their association with an important local personality, Erwin O. Freund.

Buildings 200 (M-Wing), 203, 205, 212, and 350 are the five buildings that are eligible for individual listing. Building 203 is significant because of its association with a Nobel Prize winner, Maria Goeppert-Mayer. In January 2003, ANL-E received notification that the IHPA concurred with the results of the sitewide survey regarding the eligible districts and facilities. ANL-E is developing management plans to augment the procedural mechanisms identified in the programmatic agreement and CRMP.

2.12. Floodplain Management

Federal policy on managing floodplains is contained in Executive Order 11988, "Floodplain Management" (May 24, 1977). In addition, 10 CFR Part 1022 describes DOE's implementation of this Executive Order. The Executive Order requires federal facilities to avoid, to the extent possible, adverse impacts associated with the occupancy and modifications of floodplains. To construct a project in a floodplain, DOE must demonstrate that there is no reasonable alternative to the floodplain location.

The ANL-E site is located approximately 46 m (150 ft) above the nearest large body of water (Des Plaines River); thus, it is not subject to major flooding. The 100- and 500-year floodplains are limited to low-lying areas near Sawmill Creek, Freund Brook, Wards Creek, and other small streams and associated wetlands and low-lying areas. No significant structures are located in the areas. To ensure that these areas are not adversely affected, new facility construction is not permitted within these areas, unless there is no practical alternative. Any impacts to floodplains would be fully assessed in a floodplain assessment, and, as appropriate, documented in the NEPA documents prepared for a proposed project.

2.13. Protection of Wetlands

Federal policy on wetland protection is contained in Executive Order 11990, “Protection of Wetlands” (May 24, 1977). In addition, 10 CFR Part 1022 describes DOE’s implementation of this Executive Order. The Executive Order requires federal agencies to identify potential impacts to wetlands resulting from proposed activities and to minimize these impacts. Where impacts cannot be avoided, mitigating action must be taken by repairing the damage or replacing the wetlands with an equal or greater amount of a man-made wetland as much like the original wetland as possible.

Section 404 of the CWA establishes a program to regulate the discharge of dredged and fill material into waters of the United States, including wetlands. The COE administers this program. Activities regulated under this program include disturbance of wetlands for development projects, infrastructure improvements, and conversion of wetlands to uplands for farming and forestry. The USACE uses a permit system to identify and enforce wetland mitigation efforts.

ANL-E completed a sitewide wetland delineation in 1993. All wetlands present on site were identified and mapped following the 1987 U.S. Army *Corps of Engineers Wetlands Delineation Manual.*[4] The delineation map shows the areal extent of all wetlands present at ANL-E down to 500 m^2 (1/8th acre). Thirty-five individual wetland areas were identified; their total area is approximately 18 ha (45 acres).

In February 1989, the USACE issued a permit to DOE under Section 404 of the CWA, addressing the construction of the APS facility at ANL-E. The permit was required because construction of the APS involved the filling of three small wetland areas, known as Wetlands A, B, and E, which totaled 0.7 ha (1.8 acres) in size. Issuance of the permit was contingent upon approval of a mitigation plan submitted to the USACE by DOE. The plan outlined procedures for the construction of a new wetland area, Wetland R, and also identified actions to be taken to avoid impacts to a fourth wetland, Wetland C (just under 0.4 ha (1 acre), during APS construction activities.

During October 1996, the USACE inspected Wetlands C and R and determined that they were no longer being managed in accordance with the original APS construction permit. The deficiencies noted were excessively dry soil conditions in Wetland C, caused by altered hydrology, and a poor quality biological community in Wetland R. In response to this finding, ANL-E prepared a management plan for Wetland R in January 1997 and began investigating the cause of the problems with Wetland C. The USACE verbally agreed with these response actions. Implementation of the plan began in 1997.

Mitigative actions for Wetland R, as described in the 1997 management plan, involved improving the mix of vegetation through controlled burns, herbicide application, and planting of desirable plants. Controlled burns were completed in 1997, March 2000, March 2001, and April 2002. Desirable native plants were then planted in these areas.

In 1998, the restoration of Wetland C, just under 0.4 ha (1 acre), was begun. In April 2000, the existing wetland was assessed to determine the current status and to identify alternate means of mitigating any damage incurred. This assessment determined that this area no longer meets the criteria for a wetland by virtue of the lack of appropriate hydrological conditions. The conditions no longer existed to maintain enough water in the soil to support a wetland ecology. In response to this finding, a mitigation plan for Wetland C was prepared and submitted to the USACE. This plan recommended mitigating the loss of Wetland C by developing an equivalent area of wetland in a location more conducive to the proper conditions required to sustain a wetland ecology. The proposed location is several hundred feet north of the APS facility, adjacent to a large natural wetland area. The wetland restoration could result in up to an additional 2 ha (6 acres) of wetland. The COE approved this mitigation plan on November 21, 2001.

An EA was completed in September 2001 for wetland management activities. This EA encompasses the Wetland C restoration and management activities. The IHPA concurred that the wetland restoration would not affect historic properties.

During 2002, agricultural drain tiles were removed to improve groundwater hydrology, and planting activities and herbicide application were conducted.

2.14. Wildlife Management and Related Monitoring

DOE manages the numbers of white-tailed and fallow deer at the site through an interagency agreement with the U.S. Department of Agriculture. DOE began the deer management program in 1995 to alleviate traffic safety hazards and ecological damage caused by extremely high deer densities. More than 600 deer were removed in the winter of 1995 to 1996, and more than 80 deer were removed the following winter to achieve target densities of 20 deer/mi^2 for each species. Smaller numbers of deer have been removed each year since 1997.

DOE lowered its target density for white-tailed deer to 15 deer/mi^2 in 2001 to better achieve its objectives of reducing deer and vehicle collisions, allowing oak trees to regenerate, and allowing deer-sensitive herbaceous species to recover.

DOE and the Forest Preserve District of DuPage County coordinate deer management efforts in order to preserve and enhance biodiversity at ANL-E and the surrounding Waterfall Glen Forest Preserve.

2.14.1. Deer Population Monitoring

The deer population is monitored frequently by spotlight survey to meet the requirements of Deer Population Control Permits and to aid in making deer management decisions. Forty-seven white-tailed deer were removed in the fall of 2002 to maintain the target density of 15 deer/mi^2. No fallow deer were removed in 2002.

2.14.2. Deer Health Monitoring

The health of the white-tailed deer herd is evaluated by assessing the deer that are removed each year for mean live and dressed weights and the amounts of fat stored in various organs. The health of the white-tailed deer herd has been improving since the deer management program began in 1995.

2.14.3. Deer Tissue Monitoring

Samples taken from the muscles of deer are analyzed periodically for radionuclides to verify that deer meat donated to charity does not pose a radiological health hazard. Samples sent to the IDNS radiochemistry laboratory in November 2000 were analyzed for gamma-ray-emitting radionuclides and hydrogen-3. Naturally occurring potassium-40 (at background levels) was the only gamma-ray-emitting radionuclide identified. Hydrogen-3 was not detected in any sample. No samples were collected in 2001 or 2002.

2.14.4. Vegetation Damage

Woodland vegetation is monitored periodically to determine the effects of browsing by deer on woody vegetation and to assess forest health. This monitoring is conducted to meet conditions of Deer Population Control Permits and to help make deer and habitat management decisions. DOE changed its vegetation monitoring protocol in the fall of 2000 to better gauge overall forest health. The new protocol is an adapted form of the Illinois Forest Watch Monitoring Manual issued by the Illinois Department of Natural Resources. It calls for fall surveys of woody vegetation and spring surveys of herbaceous vegetation and tree seedlings. Data collected in two sampling plots in 2000, 2001, and 2002 indicate that oak trees do not appear to be regenerating at ANL-E.

2.15. Current Issues and Actions

The purpose of this section is to summarize the most important issues related to environmental protection encountered during 2002. Table 2.15 lists all air and water effluent exceedances reported during 2002. Ongoing waste site remedial action work is described in Section 3.1.1. Exceedances of the NPDES wastewater discharge limits and Ground Water Quality Standards at the 800 Area Landfill Area are discussed in Chapters 5 and 6, respectively.

TABLE 2.15

Summary of 2002 Air and Water Effluent Exceedances

Date	Outfall	Parameter	Assessment
03/05/02	001	TDS	Salt usage associated with snowmelt and boiler blowdown
03/12/02	001	TDS	Salt usage associated with snowmelt and boiler blowdown
11/14/02	007	TRC	Domestic water leak
11/20/02	007	TRC	Domestic water leak
11/27/02	007	TRC	Domestic water leak
12/03/02	007	TRC	Domestic water leak
Ongoing	Sitewide	VOC	Cold-cleaning rule Title V
Ongoing	Building 212	NESHAPs	Unpermitted rooms (4) with potential radionuclide emissions

2.15.1. Clean Water Act – NPDES

As in previous years, ANL-E occasionally exceeded NPDES permit limits in 2002. The limit for TDS was exceeded only two times at Outfall 001 (the WTP discharge point) as compared to seven times in 2001. Boiler house blowdown and road salt runoff contribute to high TDS concentrations at Outfall 001 in the winter. The boiler house equalization pond collects runoff from salted roads in the boiler house area. To reduce winter concentrations of TDS, ANL-E connected the boiler house equalization pond to the DuPage County sewer so that up to 227,125 L/d (60,000 gal/d) of equalization pond water can be diverted from the WTP to the county sewer during the heating season. The redirection of the equalization pond wastewater was permitted by the IEPA and was begun in 2002.

ANL-E has had occasional positive toxicity test results at several outfalls. These appear to be due to residual chlorine from discharge of chlorinated drinking water into these outfalls and from cooling tower blowdown that may contain antifouling agents. Many of these discharges have been redirected into the sewer system to be processed at the WTP.

2.15.2. Solid Waste Disposal

The IEPA-approved 800 Area Landfill groundwater monitoring program continues to indicate that the Ground Water Quality Standards of some inorganic parameters consistently are being exceeded in several wells. The 1999 expansion of the groundwater monitoring well network is providing additional information about the nature of these exceedances. Additional information about the source and extent of these exceedances is needed before a plan of action to resolve the issue can be formulated. Hydrogen-3 concentration in the 800 Area Landfill wells for the past five years were evaluated. Most concentrations were below the hydrogen-3 detection limit but few wells contained hydrogen-3 levels just above the detection limits, primarily in the south and southeast direction from the landfill. Hydrogen-3 concentrations in wells on the west and north side of the landfill were below the detection limit on all of the samples reviewed. On the basis of historical analytical data from the perimeter monitoring wells, it appears that any potential for hydrogen-3 to migrate to the northwest and west and impact the water supplies of residents in those directions is extremely low. The groundwater monitoring program is discussed in detail in Section 6.3.

2.15.3. Remedial Actions

Remediation of waste management units is an ongoing compliance action. At current funding levels, the cleanup program will be completed in 2003. ANL-E currently is planning for a transition from active remediation to long-term operation, maintenance, and monitoring of these sites. These activities are described in detail in Section 3.1.1.

2.15.4. Environmental Monitoring and Surveillance Program

The DOE Office of Environment, Safety and Health Oversight (EH-24) performed an inspection of the ANL-E Environmental Monitoring Program on April 23 through April 27, 2001. The EH-24 final report identified no issues, four positive attributes, and 13 opportunities for improvement (observations). Plans were generated to address all the opportunities for improvement and these plans were approved on December 6, 2001. The plans were executed and as they were completed, progress was reported to DOE-AAO on a quarterly basis. All plans to address the 13 opportunities for improvement were completed by September 12, 2002.

2.16. Environmental Permits

Table 2.16 lists all the environmental permits in effect at the end of 2002. Other portions of this chapter discuss special requirements of these permits and compliance with those requirements.

TABLE 2.16

ANL-E Environmental Permits in Effect December 31, 2002

Type	Subject of Permit	Building	Issued	Expiration Date
Air	Title V-ANL-E	Sitewide	4/3/01	4/3/06
Air	Open-Burning Permit - Fire Dept.[a]	333	04/18/02	04/18/03
Air	Open Burning - Vegetation	Sitewide	01/29/03	01/29/04
Hazardous Waste	RCRA Part B	Sitewide	09/30/97	11/04/07
Miscellaneous	Deer Population Control Permit	Sitewide	12/02/02	03/01/03
Miscellaneous	Nuisance Wildlife Control	Sitewide	01/01/02	01/31/03
Solid Waste	Landfill	800 Area	03/31/82	-[b]
Solid Waste	Landfill	800 Area	03/30/89	-
Solid Waste	Landfill	800 Area	04/12/89	-
Solid Waste	Landfill Groundwater Assessment	800 Area	09/30/91	-
Solid Waste	Landfill Leachate Characterization	800 Area	09/30/91	-
Solid Waste	Landfill Leachate Test Wells	800 Area	08/31/90	-
Solid Waste	Landfill Revised Closure Plan[c]	800 Area	04/24/92	-
Solid Waste	Landfill Supplemental Closure Plan	800 Area	09/15/92	-
Solid Waste	Landfill Supplemental Permit Groundwater	800 Area	04/19/94	-
Solid Waste	Landfill Supplemental Permit Groundwater	800 Area	01/11/95	-
Solid Waste	Landfill Supplemental Permit Groundwater	800 Area	11/20/97	-
Solid Waste	Landfill Supplemental Permit Groundwater	800 Area	08/25/98	-
Solid Waste	Landfill Supplemental Permit Groundwater	800 Area	06/16/99	-
Solid Waste	Landfill Supplemental Permit Groundwater	800 Area	4/25/00	-
Solid Waste	Landfill Supplemental Permit Landfill Gas	800 Area	10/01/02	-
Water	Discharge to DuPage County Public Works	100 Area	08/10/01	-
Water	Lime Sludge Application - Land Application	Sitewide	10/01/02	09/30/07
Water	NPDES Permitted Outfalls	Sitewide	10/31/94	-[d]

[a] This unit has been designated as an insignificant source in the ANL-E Title V Permit.

[b] A hyphen indicates that the permit remains in effect until superseded.

[c] Includes gas monitoring program.

[d] Existing permit continues to be in effect while revised permit application is undergoing IEPA review.

3. ENVIRONMENTAL PROGRAM INFORMATION

3.1. Major Environmental Programs

DOE and ANL-E policies require that all operations be conducted in compliance with applicable environmental statutes, regulations, and standards, and that environmental obligations be carried out consistently across all operations and organizations. Protection of the environment and human health and safety always are given the highest priority. A number of programs and organizations exist at ANL-E to ensure compliance with these authorities and to monitor and minimize the impact of ANL-E operations on the environment.

The ANL-E Environmental Remediation Program (ERP) is responsible for achieving compliance with all applicable environmental requirements related to assessing and cleaning up releases of hazardous materials from inactive waste sites. The corrective action portion of the RCRA Part B Permit provides the primary regulatory vehicle, although several voluntary cleanup projects are included in the program.

3.1.1. Remedial Actions Progress in 2002

In 2002, ANL-E continued to implement its plan to complete all remedial actions at the site by the end of 2003. The plan is described in a document titled *Environmental Restoration Program (EM-40) Baseline for Argonne National Laboratory-East*[5] that was completed in early 1999.

As of the end of fiscal year (FY) 2002, out of the total number of SWMUs listed in the RCRA Part B Permit — 49 SWMUs and 6 AOCs — and three voluntary cleanup projects, the ERP had completed remediation work on 47 SWMUs and AOCs and had received final acknowledgment from the IEPA of either a NFA or No Further Remediation (NFR) (for long-term operation and maintenance [O&M] sites) on 38 sites.

In FY 2002, the ERP worked on 11 sites, completing assessment or design work on 4, final cleanup fieldwork on 6, and continuing remediation activities on 1 (the lime sludge project). Reports were submitted to the IEPA requesting NFA for 6 of these sites.

Table 3.1 lists each of the release sites worked on during the fiscal year, the scope of the work, and whether or not the work resulted in a request to the IEPA for NFA.

As part of an ongoing effort to assess the efficacy of the long-term remedial actions within the 300 Area, specifically the 317 and 319 Areas of the site, the ERP conducted an exhaustive evaluation of the existing systems in the area and arrived at several recommendations for future work. The main recommendation was to accelerate the removal of residual soil contamination near the former 317 Area French Drain and to increase the amount of contaminated groundwater removed

TABLE 3.1

Status of Release Sites, 2002

Site Name	Site Number	FY 2002 Work Scope	NFA Requested in FY 2002
317 Area Deep Vault	Release Site No. 743	Demolished and backfilled the vault. Fieldwork completed.	NA[a]
Newly Identified Suspected Solid Waste Landfill	SWMU No. 744	The IEPA approved the remedial design and remediation fieldwork was completed. The construction report was submitted to the IEPA requesting NFA for the soil portion. A separate request will be submitted to the IEPA for NFA relative to groundwater.	Yes
Freund Ponds	SWMU No. 7	Characterization plan approved by the IEPA. Completed characterization fieldwork and submitted a final report to the IEPA requesting NFA.	Yes
Lime Sludge Pond	Former SWMU No. 8	Removed an additional 15,000 yd^3 of lime sludge from the lagoon	No
570 Area - Unlined Holding Basin	SWMU No. 133	Prepared construction work plan and received IEPA approval. Started remediation fieldwork.	No
Bldg. 34 Mixed Liquid Waste Treatment	SWMU No. 150	The IEPA granted NFA for soil. Groundwater remediation fieldwork was completed and the construction report was submitted to the IEPA requesting NFA.	Yes
Storm Sewers - Cooling Tower Wastewater	SWMU No. 179	Completed a Tier 3 ecological effects assessment and a human health risk assessment and submitted them to the IEPA with a request for NFA.	Yes

TABLE 3.1

Status of Release Sites, 2002 (Cont.)

Site Name	Site Number	FY 2002 Work Scope	NFA Requested in FY 2002
Bldg. 330 Yard with Mixed Materials for Decom-missioning	SWMU No. 151	Prepared supplemental groundwater investigation work plan, which received IEPA approval.	No
Building 310 Retention Tank and Sump	SWMU Nos. 104, 105, 106, and 721	Prepared characterization plan, completed characterization fieldwork, and completed and submitted a final report to the IEPA requesting NFA.	Yes
320 Area Shooting Range	SWMU No. 498	Completed remedial design, received IEPA approval. Completed remediation fieldwork, prepared construction report and submitted to the IEPA with a request for NFA.	Yes

[a] NA indicates “not applicable.” The remediation work performed at these sites does not come under RCRA jurisdiction.

from the source area. Several enhancements to the existing remedial systems were devised to accomplish these objectives. DOE approved the proposed actions.

The phytoremediation plantation in the 317 Area continued to grow and mature throughout the year. Tissue samples collected from the trees indicated that the trees are taking up chlorinated organic compounds as they were expected to do. Information collected as part of the assessment of conditions in the 300 Area indicates that the trees could be made even more effective by reducing the amount of shallow groundwater. The shallow groundwater prevents the tree roots from penetrating to the desired depth, since the roots stop growing when they reach water. The proposed enhancements discussed above include steps to reduce the amount of shallow groundwater.

Routine operations and monitoring of the two groundwater extraction systems south of the 317 and 319 Areas were carried out. Monitoring of these systems shows that they are generally operating as intended, by preventing contaminated groundwater from leaving the site. On the western extent of the 317 Area system, ANL-E discovered that the contaminant plume had apparently shifted westward and could be bypassing the westernmost extraction well. To remedy this, ANL-E installed two additional wells and fit them with extraction pumps.

3.1.2. Environmental Monitoring Program Description

As required by DOE Orders 5400.1[1] and 231.1,[2] ANL-E conducts a routine environmental monitoring program. This program is designed to determine the effect of ANL-E operations on the environment surrounding the site. This section describes this monitoring program. In 2002, a total of 2,007 samples were collected and 26,026 analyses were performed. A general description of the rationale for sampling for each media is presented. Greater detail is provided in the ANL-E Environmental Monitoring Plan.

3.1.2.1. Air Sampling

ANL-E conducts an air monitoring program for conventional and radioactive pollutants to assess the impact of ANL-E operations on the environment and the public health. Air monitoring is necessary since the NESHAPs radiological inventory indicates that sufficient material is used in laboratory hood applications that a potential exists for releases. Monitoring also is conducted to estimate radiological releases that could occur if the high-efficiency particulate air (HEPA) filters failed. In addition, several major facilities have radiological airborne emissions because of the nature of the operation. Examples of these emissions are air activation products from the APS and IPNS and hydrogen-3 from the Alpha Gamma Hot Cell Facility. The air monitoring program consists of effluent monitoring and environmental surveillance of airborne contaminants. Effluent monitoring primarily includes continuous monitoring of airborne effluents (radionuclides and conventional pollutants) from stacks. Environmental surveillance includes continuous direct collection of airborne pollutants on filters at selected stations located around the perimeter of ANL-E, and off-site analysis of the collected particulate matter for radionuclides.

3.1.2.2. Water Sampling

Water samples are collected to determine what, if any, radionuclides or selected hazardous chemicals used or generated at ANL-E enter the environment by the water pathway. Surface water samples are collected from 28 NPDES outfalls and from Sawmill Creek below the point at which ANL-E discharges its treated wastewater. The results of radiological analysis of water samples at these locations are compared with upstream and off-site results to determine the ANL-E contribution. The results of the chemical analyses are compared with the applicable IEPA stream quality standards to determine whether the site is degrading the quality of the creek. These results are discussed in more detail in Chapters 4 and 5.

Surface water samples are collected from Sawmill Creek and combined into a single weekly composite sample. A continuous sampling device has been installed at this location to improve sample collection representativeness. To provide control samples, Sawmill Creek is sampled upstream of ANL-E once a month. The Des Plaines River is sampled twice a month below, and monthly above, the mouth of Sawmill Creek to determine whether radionuclides in the creek are detectable in the river.

In addition to surface water, subsurface water samples also are collected at 51 locations. These samples are collected quarterly from monitoring wells located near areas that have the potential for adversely impacting groundwater. These areas are the 800 Area Landfill, the 317/319 waste management area, the ENE Landfill, the 570 Area, and the site of the inactive CP-5 reactor. Samples from the three on-site wells that formerly provided domestic water also are collected and analyzed for hazardous and radioactive constituents. The monitoring wells are purged, and samples are collected from the recharged well water. These samples are analyzed for both chemical and radiological constituents, as discussed in Chapter 6. Samples are collected quarterly from the wellheads of the three ANL-E wells that formerly provided the domestic water supply. The water is pumped to the surface and collected in appropriate containers, depending on the required analysis. The ANL-E groundwater monitoring program is summarized in Table 3.2.

At the time of sample collection for radiological analysis, the sampling location, time, date, and collector identification number are recorded on a label attached to the sample container. Upon return to the laboratory, the information is transferred to the Environmental Protection Data Management System (EMS). Each sample is assigned a unique number that accompanies it through all analyses. After the sample has been logged in, an aliquot is removed for hydrogen-3 analysis; 20 mL (1 oz) of concentrated nitric acid is added per gallon of water as a preservative, and the sample is filtered through Whatman No. 2 filter paper to remove any sediment present in the sample. Appropriate aliquots are then taken, depending on the analysis.

TABLE 3.2

Summary of Groundwater Monitoring Program by Area, 2002[a]

	ANL-E Site	East Area	317/319 Area	800 Area
Number of wells	87	38	177	73
Wells monitored	4	13	54	28
Sampling events	16	52	216	112
Analyses	122	66	644	1344
Results	1,040	263	4,492	8,540
% Nondetects	97	90	92	82

[a] Because of program integration, the wells monitored, sampling events, analyses, results, and nondetectable results overlap between monitoring purposes.

For nonradiological analysis, samples are collected and preserved using EPA-prescribed procedures. Cooling is used for organic analysis, and nitric acid is used to preserve samples to be analyzed for metals. Specific collection procedures are used for other components, and EPA methods are used. All samples are analyzed within the required holding period, or noncompliance is documented. The quality control requirements of either SW-846, *Test Methods for Evaluating Solid Waste: Physical and Chemical Methods*,[6] or the Contract Laboratory Program (CLP) must be met, or deviations are documented. Each sample is assigned a unique number that serves as a reference source for each sample. When duplicate samples are obtained, unique numbers are assigned, and an indication that duplicates exist is entered in the data management system.

3.1.2.3. Bottom Sediment

Bottom sediment accumulates small amounts of radionuclides that may be present from time to time in a stream and, as a result, acts as an accumulator of the radionuclides that were present in the water. The sediment provides evidence of radionuclides in the surface water system. These samples are not routinely analyzed for chemical constituents. Bottom sediment samples are collected annually from Sawmill Creek above, at, and from several locations below the point at which ANL-E discharges its treated wastewater. Sediment is collected from each location with a stainless-steel scoop and is transferred to a glass bottle.

At the time of sample collection, the date, time, and sample collector identification are recorded on sample labels affixed to the sample container. Upon return to the laboratory, the information is transferred to the EMS. Each sample is assigned a unique number that accompanies it through the process.

Each sample is dried for several days at 110°C (230°F), ball milled, and sieved through a No. 70 mesh screen. The material that does not pass the No. 70 screen is discarded. A 100-g (4-oz) portion is taken for gamma-ray spectrometric measurement, and other appropriate aliquots are used for specific radiochemical analyses.

3.1.2.4. External Penetrating Radiation

Measurements of direct penetrating gamma radiation emanating from several sources within ANL-E are taken by using aluminum oxide thermoluminescent dosimeters (TLDs) provided by a commercial vendor. Each measurement is the average of two chips exposed in the same packet. Dosimeters are exposed at 17 locations at the site perimeter and on site, and at five off-site locations. All dosimeters are changed quarterly. At the time of dosimeter collection, the date, time, and collector identification number are recorded on a preprinted label affixed to the container. Each sample is assigned a unique number that accompanies it through the process. After completion of the exposure period, the TLDs are mailed to the vendor for reading. When the dose information is provided to the on-site laboratory by the vendor, it is entered into the EMS.

A fast neutron monitoring program was established in 2002 to determine if any neutron dose was measurable in the vicinity of facilities that had the potential to produce fast neutrons. Four environmental neutron dosimeters were placed at locations around the IPNS facility that were most likely to result in neutron dose. A fifth dosimeter was placed off site to monitor background neutron doses in an area unaffected by ANL-E operations. The neutron dosimeters were changed quarterly, mailed to the vendor for reading, and entered into the EMS upon receipt.

3.1.2.5. Data Management

ANL-E manages the large amount of data assembled in the environmental monitoring program in a structured manner that allows a number of reports to be generated. Basic data management, including sample record keeping, is implemented with the EMS computerized record-keeping system. All sample and analytical data are maintained in the EMS for eventual output in formats required for either regulatory compliance reports or for annual reports. In addition, reports are provided for trend analysis, statistical analysis, and tracking.

The ANL-E–developed EMS is the basic data management tool; it generates sampling schedules, all other tracking and calculation routines, and the final analytical result tabulations. The EMS is set up for the radiological portion of the monitoring program and for nonradiological monitoring for groundwater and NPDES surface water effluents.

The starting point for effluent monitoring and environmental surveillance is establishing a set of sampling locations and a sample schedule. On the basis of regulatory parameters, pathway analysis, or professional judgment, sample locations for the various media are identified and entered into the EMS. For each sample location, nine categories of data are entered into the EMS: geographic code, location description, sampling frequency, sample type, exact sampling position, last date sampled, sampling priority (same location with multiple samples), size of sample to collect, and analytes.

Once the data are entered, the EMS is used to generate a sampling schedule. Every week a schedule for the next week is printed out, along with uniquely numbered preprinted labels for the sample containers. These items are provided to the staff who conduct the sampling in the field. Field data are entered into the EMS. At the time the samples are submitted to the analytical laboratory, chain of custody documents are generated. The EMS distributes sample data electronically (via diskette) to the Environment, Safety and Health (ESH) data management system and accepts back the analytical data (via diskette or e-mail).

As the laboratory results are compiled, the data are entered into the EMS. This permits up-to-date tracking of all samples currently in process. When the analysis for each sample is completed and the results electronically entered into the EMS, the completed final results sample card is retained in a file as an additional quality assurance (QA) measure.

Complete data sets for all samples are maintained by the EMS. When all results have been completed and entered into the EMS, a final result card is generated that lists all data related to each sample. The electronic files are backed up by the computer network server. The printed final result card is filed after review, then ultimately placed in DOE's archives in Chicago. Final results are thus available both on line via the network and in hard copy.

3.1.3. Waste Minimization and Pollution Prevention

During 2002, ANL-E continued to enhance its past pollution prevention and waste minimization efforts. ANL-E continues to develop and implement a comprehensive sitewide Pollution Prevention (P2) Program in accordance with local, state, federal, DOE, and site-specific P2 regulations and requirements. The P2 Program performs tracking and trending of waste and pollution at ANL-E, and monitors the progress with regard to DOE P2/Energy Efficiency (E2) Goals and Performance Measures. ANL-E continues to maintain waste generation rates below the levels established by the DOE P2 and E2 Leadership Goals.

ANL-E management has always fostered a work environment that promotes the development and implementation of P2 activities. To that end, ANL-E management has instituted a P2 Policy Statement and a requirement that all new project reviews include the use of a P2 Review Checklist. ANL-E management has consistently promoted the integration of P2 strategies into all areas of the ANL-E. ANL-E's management has used the Integrated Safety Management (ISM) System to promote and institutionalize P2 strategies across the ANL-E site.

In keeping with its commitment to continuous improvement, ANL-E accomplished the following P2-related highlights during 2002.

3.1.3.1. P2 Assessments and Reviews

Historically, the ANL-E P2 Program has identified, developed, and performed Pollution Prevention Opportunity Assessments (PPOAs) and Process Waste Assessments (PWAs).

The P2 Program and the P2 Advisory Committee continued performing PWAs on high volume/cost waste generators at ANL-E. During FY 2002, the following PWA's resulted in waste reductions and savings of approximately $109,000.

- Building 46 Vehicle Maintenance,
- Building 202 Silver Staining Process,
- Erosion Control System for the Coal Storage Yard,
- Characterization Project for the Alpha Gamma Hot Cell,
- APS-XFD Optics Fabrication Laboratory, and
- Building 376 High Bay H Engine.

As a related matter, the P2 Program developed a disposition plan for the management of sources and excess nuclear materials currently stored or generated on site. The P2 Program coordinated site visits by the Nonactinide Isotopes and Sealed Sources Management Group. The group assisted ANL-E with development of the disposition plan, with specific recommendations for end use options for sources and excess nuclear materials.

In an effort to increase the understanding and implementation of PWAs, the P2 Program provided a PWA training workshop and developed PWA guidance materials for ANL-E personnel. The P2 Program has also worked to integrate P2 into the project review process. This has resulted in a newly modified NEPA Environmental Review Form that includes P2 components and a requirement that all new project reviews include the use of the P2 Review Checklist.

3.1.3.2. Waste Reduction and Recycling

ANL-E’s comprehensive solid waste recycling program effectively recycles/reduces the following waste/materials: surplus laboratory chemicals, mixed office paper, cardboard, aluminum, glass, plastics, metals, toner cartridges, construction and demolition debris, fly ash, coal fines, sanitary waste sludge, lead, lead acid batteries, transparencies, fluorescent lightbulbs, computers, and electronic equipment. ANL-E annually maintains sanitary waste levels below the 2005 DOE P2 target goals and recycles materials at levels beyond the established goal of 45%. During FY 2002, ANL-E recycled 80% of sanitary waste from all operations. Since 1996, ANL-E has recycled over 82,000 t (90,000 tons) of materials, generating cost savings estimated at over $3.8 million.

ANL-E has consistently generated routine LLW, mixed waste, and hazardous waste at levels below the 2005 DOE Pollution Prevention target goal. ANL-E aggressively tracks, reviews, and assesses (PPOA and PWA) the hazardous and radioactive waste streams in an effort to identify alternatives to disposal (e.g., segregation, treatment, reuse, recycling, etc.) for these materials/wastes.

ANL-E has developed programs to allow employees and contractors to minimize waste and prevent pollution. Below are a few examples of the many programs available to ANL-E employees:

- The Argonne Chemical Exchange System was developed to facilitate the exchange of surplus chemicals across ANL-E. This system is linked to the ES&H Chemical Management System and incorporates the use of a centralized surplus chemical storage facility. During the first year, this program was successful with approximately 45 chemical exchanges for reuse in place of disposal.

- The Surplus Office Supply Exchange is a program developed to recycle and reuse surplus office supplies and furniture. The Argonne Equipment and Materials Exchange is a similar program developed to recycle and reuse surplus equipment, supplies, and materials by promoting the AVAILABILITY or NEED of items via the ANL-E e-mail system. These programs were instrumental in the reuse of over $100,000 of equipment, supplies, and materials during FY 2002.

3.1.3.3. Affirmative Procurement Program

ANL-E's commitment to environmental quality, as demonstrated by the purchasing of environmentally preferable products, has resulted in an award winning Affirmative Procurement Program. These efforts have made it easier for employees to purchase recycled-content products, made it less difficult to track purchases, and heightened the overall awareness level for buying recycled.

3.1.3.4. Sustainable Design

ANL-E has developed and implemented a Sustainable Design Implementation Plan that promotes environmentally preferable building materials and construction methods within facility design and construction projects. The program includes a Sustainable Design policy, a NEPA checklist, specification changes, procurement guidance, documentation and training, and guidance for design staff. By implementing the plan, ANL-E diverts waste from the landfill; reduces facility energy use, resource consumption, and operating costs; improves indoor air quality; and stimulates the economy for sustainable products and services. These efforts resulted in ANL-E having the first DOE Leadership in Energy and Environmental Design (LEED) Certified building in 2002. The Central Supply Facility received the Silver LEED rating this past year.

In addition, the ANL-E P2 Program has coordinated a pilot program that utilizes native plants to landscape courtyards. This type of landscaping will eliminate the need for mowing, thereby saving money and energy.

3.1.3.5. Environmental Remediation

Through the employment of several innovative technologies and working closely with regulatory agencies, ANL-E has been successful in reducing what otherwise would have been a substantial amount of investigative and remediation waste. Specifically, by utilizing technologies such as enhanced soil mixing with zero-valent iron addition and phytoremediation, ANL-E eliminated the need to excavate more than 20,000 m^3 (26,000 yd^3) of highly contaminated soil. In addition, ANL-E has found a use for a lime sludge that would normally require off-site disposal as a special waste. The sludge is currently being applied to agricultural land as a soil conditioner. This application has kept approximately 100,000 m^3 (140,000 yd^3) of sludge out of landfills and utilized its beneficial properties. As a whole, the ANL-E environmental remediation activities have resulted in cost savings estimated beyond $7.7 million. Through these efforts, the ANL-E ERP received a DOE National P2 Award in 2002.

3.2. Environmental Support Programs

3.2.1. Self-Assessment

In line with the principles of ISM, line management is responsible for internal self-assessment. This process focuses on the activities of an individual organization and is intended to stimulate continuous improvement. The results are reported to those who have the authority and responsibility for the organization’s performance. At the beginning of the calendar year, each organization develops an agenda of activities to be reviewed. A schedule is prepared, and assignments are made to manage the organization’s self-assessment program. The ANL-E-wide results and conclusions of the assessment program are summarized by line management and submitted to the Director of the Office of ESH/QA Oversight (EQO). The actual performance during the year is monitored by the line organization as well as by the oversight organization assisting senior management in fulfilling its oversight responsibilities.

3.2.2. Environmental Training Programs

ANL-E has a comprehensive environmental protection training program that includes mechanisms to identify, track, and document training requirements for every employee. Environmental protection training for ANL-E personnel is provided primarily by the EQO Training Section, although some training may be delivered by subject-matter experts from other organizations. Personnel training addresses various requirements, such as those contained in DOE Orders, or EPA or U.S. Department of Transportation regulations. Required training is identified by a Job Hazards Checklist form that is completed by every employee and is reviewed by each employee's supervisor.

Activities are managed through the Training Management System, an on-line computer-based system that tracks the training status of each employee. Environmental protection training courses and course descriptions are listed in the Training Course Catalog available from divisional training management system representatives, the EQO Training Section, or Human Resources.

3.2.3. Site Environmental Performance Measures Program

Effective FY 1995, the Prime Contract between DOE and The University of Chicago to operate ANL-E made provisions for a fee based on the performance of various research and operations activities, including ESH and Projects and Infrastructure Management performance. Performance objectives and supporting metrics have been developed as a part of the contract and for determination of the performance fee. At the end of the performance period, a rating (outstanding, excellent, good, or marginal) is assigned to each. These ratings are part of the basis for the performance fee.

For the period of the performance-based contract October 2001 to September 2002, the environmental measurements were included in two categories. One category was identified as the ESH category and the other as Projects and Infrastructure Management. The ratings of the measurements in these categories directly affected the performance-based fee. The environmental measurements include the following:

- Compliance with environmental permit conditions (outstanding);
- Compliance with air and water effluent limits (outstanding);
- Compliance with environmental project schedule (outstanding);
- Compliance with environmental project cost (outstanding);
- Waste minimization/pollution prevention (outstanding); and

- Specific deliverables for Executive Order 13148 and DOE Notice 450.4 (outstanding).

The overall rating of the Projects and Infrastructure Management categories, based on a roll-up of the individual performance ratings during the contract period, was outstanding.

3.2.4. Executive Order 13148 — Greening of the Government

On April 21, 2000, President Clinton signed Executive Order 13148, “Greening of the Government Through Leadership in Environmental Management.” The new Executive Order incorporates directives from previous Executive Orders 12843, 12856, and 12969, as well as the Executive Memorandum of April 26, 1994, and also adds new requirements. The new Executive Order is applicable to all federal agencies, including DOE. The goals of the Executive Order are to:

- Develop and implement environmental management systems,
- Ensure compliance with all environmental regulations,
- Continue to conduct EPCRA Section 313 reporting,
- Reduce the use of chemicals reportable under TRI reporting,
- Reduce the procurement and use of toxic chemicals and hazardous substances,
- Phase out the procurement of Class 1 Ozone Depleting Substances, and
- Strive to promote environmentally and economically beneficial landscaping.

Attachment 1 of DOE Notice 450.4, dated June 1, 2002, assigns contractor responsibilities for the implementation of Executive Order 13148. ANL-E prepared a compliance action plan to address each of the eight contractor requirements, which was submitted to DOE on July 25, 2002. The plan identifies the ANL-E status of each requirement relative to current ANL-E environmental programs. The major area requiring compliance is the section on environmental management systems. ANL-E formally committed to incorporating its environmental management system into its ISM Program. ANL-E will prepare an environmental management system program description document describing the processes for ensuring compliance with applicable environmental regulations, orders, and permits, along with environmental improvement initiatives that are consistent with the goals stipulated in Executive Order 13148. ANL-E prepared the environmental management system description document; the first draft was completed by the end of the year.

3.2.5. Ecological Restoration Program

DOE and ANL-E recognize the importance of enhancing and preserving biodiversity and have committed to supporting the Biodiversity Recovery Plan prepared by Chicago Wilderness partnership organizations. Ongoing ecological restoration activities include enhancing oak woodland, savanna, wetland, and prairie habitats in the undeveloped areas on the ANL-E site. Six acres of vacant land that was formerly occupied by Quonset huts has been converted to prairie. Controlled burns and hand clearing of invasive shrubs are restoring sunlight to oak woodlands so that native flowers and grasses can grow. The upland area around a site wetland has been planted with prairie species to cleanse water feeding the wetland. The area surrounding a man-made pond outside the main administrative building is being used to demonstrate the use of native plants for landscaping after invasive weedy plants were removed and replaced by native species.

ANL-E is implementing, where practical, Executive Order 13112, "Invasive Species" (February 3, 1999), and Guidance for Presidential Memorandum on Environmentally and Economically Beneficial Landscape Practices on Federal Landscaped Grounds (Volume 60, *Federal Register*, page 40837).

3.3. Compliance with DOE Order 435.1

DOE Order 435.1 "Radioactive Waste Management,"[7] requires that an environmental monitoring and surveillance program be conducted to determine any releases or migration from LLW treatment, storage, or disposal sites. Compliance with these requirements is an integral part of the ANL-E sitewide monitoring and surveillance program. Waste management operations in general are covered by relying on the perimeter air monitoring network and monitoring of the liquid effluent streams and Sawmill Creek. The analytical results are presented in Chapter 4 of this report.

Of particular interest is monitoring of the waste management activities conducted in the 317 Area. These include air particulate monitoring for total alpha, total beta, and gamma-ray emitters, and radiochemical determinations of plutonium, uranium, thorium, and strontium-90; direct radiation measurements with TLDs; surface water discharges for hydrogen-3 and gamma-ray emitters; and subsurface water samples at all the monitoring wells with analyses for hydrogen-3, strontium-90, and gamma-ray emitters, plus selected monitoring for VOCs. Direct radiation measurements are also conducted at other waste management areas: Building 306, Building 331, and the 398A Area. The results are presented in Chapters 4 and 6 of this report.

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

4.1. Description of Monitoring Program

The radioactivity of the environment around ANL-E in 2002 was determined by measuring radionuclide concentrations in air, surface water, subsurface water, and sediment, and by measuring the external photon penetrating radiation and potential neutron exposure. Sample collections and measurements were made at the site perimeter and off site for comparative purposes. Some on-site results are also reported when they are useful in interpreting perimeter and off-site results.

Because radioactivity is primarily transported by air and water, the sample collection program concentrates on these media. In addition, samples of materials from the streambeds also are analyzed. The program follows the guidance provided in the DOE Environmental Regulatory Guide.[8] The results of radioactivity measurements are expressed in terms of pCi/L for water; fCi/m^3 and aCi/m^3 for air; and pCi/g and fCi/g for bottom sediment. Penetrating radiation measurements are reported in units of mrem/yr, and population dose is reported in units of person-rems.

DOE has provided guidance[9] for effective dose equivalent calculations for members of the public based on International Commission on Radiological Protection (ICRP) Publications 26 and 30.[10,11] Those procedures have been used in preparing this report. The methodology requires that three components be calculated: (1) the committed effective dose equivalent (CEDE) from all sources of ingestion, (2) the CEDE from inhalation, and (3) the direct effective dose equivalent from external radiation. These three components were summed for comparison with the DOE effective dose equivalent limits for environmental exposure. The guidance requires that sufficient data on exposure to radionuclide sources be available to ensure that at least 90% of the total CEDE is accounted for. The primary radiation dose limit for members of the public is 100 mrem/yr. The effective dose equivalents for members of the public from all routine DOE operations (natural background and medical exposures excluded) shall not exceed 100 mrem/yr and must adhere to the as-low-as-reasonably-achievable (ALARA) process or be as far below the limits as is practical, taking into account social, economic, technical, practical, and public policy considerations. Routine DOE operations are normally planned operations and exclude actual or potential accidental or unplanned releases.

The measured or calculated environmental radionuclide concentrations were converted to a 50-year CEDE with the use of the CEDE conversion factors[12] and were compared with the annual dose limits for uncontrolled areas. The CEDEs were calculated from the DOE Derived Concentration Guides (DCGs)[9] for members of the public on the basis of a radiation dose of 100 mrem/yr. The numerical values of the CEDE conversion factors used in this report are provided later in this chapter (Table 4.27). Occasionally, other standards are used, and their sources are identified in the text.

4.2. Air

The radioactive content of particles in the air was determined by collecting and analyzing air filter samples. The sampling locations are shown in Figures 1.1 and 1.2. ANL-E uses continuously operating air samplers to collect samples for the measurement of concentrations of airborne particles contaminated by radionuclides. Currently, nonradiological air contaminants in ambient air are not monitored. Particle samplers are placed at 13 locations around the ANL-E perimeter and at six off-site locations, approximately 8 km (5 mi) from ANL-E, to determine the ambient or background concentrations.

Airborne particle samples for measurement of total alpha, total beta, and gamma-ray emitters are collected continuously at 12 perimeter locations and at five off-site locations on glass fiber filter media. Average flow rates on the air samplers are about 70 m^3/h (2,472 ft^3/h). Filters are changed weekly. ANL-E staff change the filters on perimeter samplers, and the filters on off-site samplers are changed and mailed to ANL-E by cooperating local agencies. Additional samples of particles in air, used for radiochemical analysis of plutonium and other radionuclides, are collected at one perimeter location and at one off-site location. These samples are collected on special filter media that are changed by ANL-E staff every 10 days. The sampling units are serviced every six months, and the flow meters are recalibrated annually.

At the time of sample collection, the date and time when sampling was begun and the date and time when the sample was collected are recorded on a label attached to the sample container. The samples are then transported to ANL-E where this information is then transferred to the EMS.

Each air filter sample collected for alpha, beta, and gamma-ray analyses is cut in half. Half of each sample for any calendar week is combined with all the other perimeter samples from that week and packaged for gamma-ray spectrometry. A similar package is prepared for the off-site filters for each week. A 5-cm (2-in.) circle is cut from the other half of the filter, mounted in a 5-cm (2-in.) low-lip stainless-steel planchet, and counted to determine alpha and beta activity. The remainder of the filter is saved.

The air filter samples collected for radiochemical analysis are composited by location for each month. After the addition of appropriate tracers, the samples are ashed, then sequentially analyzed for plutonium, thorium, uranium, and strontium, because these radionuclides are those most likely to be in the air due to ANL-E operations.

Stack monitoring is conducted continuously at five locations (see Section 4.7.1), that is, those emission points that have a probability of releasing measurable concentrations of radionuclides. The results of these measurements are used to estimate the annual off-site dose using the required EPA CAP-88 (Clean Air Act Assessment Package-1988)[13] atmospheric dispersion computer code and dose conversion method.

Samples were collected at the site perimeter to determine whether a statistically significant difference exists between perimeter measurements and measurements taken from samples collected at various off-site locations. The off-site samples establish the local background concentrations of naturally occurring or ubiquitous man-made radionuclides, such as from nuclear weapons testing fallout. Higher levels of radioactivity in the air measured at the site perimeter may indicate radioactivity releases from ANL-E, provided that the perimeter samples are greater than the background samples by an amount greater than the relative error of the measurement. The relative error is a result of natural variation in background concentrations as well as sampling and measurement error. This relative error is typically 5 to 20% of the measurement value for most of the analyses, but approaches 100% at values near the detection limit of the instrument.

Table 4.1 summarizes the monthly total alpha and beta activities for the individual weekly sample analyses. These measurements were made in low-background gas-flow proportional counters, and the counting efficiencies used to convert counting rates to disintegration rates were those measured for a 0.30-MeV beta and a 5.5-MeV alpha on filter paper. The results were obtained by measuring the samples four days after they were collected to avoid counting the natural activity due to short-lived radon and thoron decay products. This activity is normally present in air and disappears within four days by radioactive decay. The average concentrations of gamma-ray emitters, as determined by gamma-ray spectrometry performed on composite weekly samples, are given in Table 4.2. The gamma-ray detector is a shielded germanium diode calibrated for each gamma-ray–emitting nuclide measured.

Comparison of perimeter to off-site alpha and beta concentrations over the past several years shows that the perimeter results are consistently lower. This was most pronounced this year, particularly during the summer months. An investigation of this difference showed that there was significantly less particulate material collected on the perimeter air filters. In addition, the off-site samples would occasionally not be changed on the weekly schedule and run for two weeks. These samples would have a significant amount of particulate material on the filter. The differences in concentration appear to be a function of the mass of material on the filter, which is probably related to the location of the air sampler. The perimeter samplers are sited in grassy, open areas, away from buildings, roads, and other sources of airborne particulate material. The off-site samplers are located within municipal complexes, within secured locations, and are typically exposed to higher levels of airborne particulate material, especially resuspended soil, which contains naturally occurring radionuclides.

The perimeter beta activity averaged 16 fCi/m^3, which is similar to the average value for the past five years. The gamma-ray emitters listed in Table 4.2 are those that have been present in the air for past years and are of natural origin. The beryllium-7 concentration increases in the spring, which indicates its stratospheric origin. The concentration of lead-210 in the air is due to the radioactive decay of gaseous radon-222 and is similar to the concentration last year. The annual

TABLE 4.1

Total Alpha and Beta Activities in Air Filter Samples, 2002
(concentrations in fCi/m^3)

			Alpha Activity			Beta Activity		
Month	Location	No. of Samples	Avg.	Min.	Max.	Avg.	Min.	Max.
January	Perimeter	60	1.5	0.4	3.1	20.4	7.1	35.2
	Off-Site	16	2.2	0.7	5.1	15.4	2.7	35.6
February	Perimeter	47	1.2	0.4	2.1	17.5	5.6	38.9
	Off-Site	12	1.5	0.7	2.8	8.9	1.0	28.3
March	Perimeter	44	1.5	0.7	2.7	18.4	7.5	33.5
	Off-Site	14	2.2	0.3	4.4	12.0	2.2	30.4
April	Perimeter	45	1.2	0.4	2.0	13.0	5.6	21.4
	Off-Site	16	1.3	0.1	2.9	8.3	0.9	20.7
May	Perimeter	59	1.0	0.4	2.1	10.5	4.3	23.5
	Off-Site	16	0.9	0.1	2.1	4.8	0.7	11.7
June	Perimeter	48	1.0	0.2	1.9	11.1	3.0	22.8
	Off-Site	16	1.3	0.2	2.7	6.9	1.3	16.0
July	Perimeter	59	1.1	0.1	2.2	13.9	2.2	30.6
	Off-Site	18	1.8	0.5	3.5	13.0	2.2	34.5
August	Perimeter	44	0.7	0.1	1.3	11.7	3.3	22.9
	Off-Site	17	1.3	0.3	2.2	10.9	2.5	27.7
September	Perimeter	46	1.1	0.6	2.4	16.7	7.3	31.1
	Off-Site	16	1.8	0.1	4.2	14.9	1.6	35.8
October	Perimeter	58	1.3	0.5	2.3	16.3	6.8	28.8
	Off-Site	13	2.2	0.6	3.5	20.8	1.8	35.0
November	Perimeter	48	1.5	0.6	3.5	19.3	5.5	51.5
	Off-Site	9	3.1	0.6	5.4	27.1	1.7	63.7
December	Perimeter	48	1.7	0.6	3.3	19.2	8.2	35.3
	Off-Site	12	2.9	0.7	7.3	21.3	1.3	48.2
Annual	Perimeter	606	1.2 ± 0.2	0.1	3.5	15.7 ± 2.2	2.2	51.5
summary	Off-Site	175	1.9 ± 0.4	0.1	7.3	13.7 ± 4.2	0.7	63.7

TABLE 4.2

Gamma-Ray Activity in Air Filter Samples, 2002
(concentrations in fCi/m^3)

Month	Location	Beryllium-7	Lead-210
January	Perimeter	43	21
	Off-Site	32	17
February	Perimeter	68	19
	Off-Site	26	9
March	Perimeter	94	18
	Off-Site	55	11
April	Perimeter	67	13
	Off-Site	43	6
May	Perimeter	60	9
	Off-Site	24	4
June	Perimeter	67	11
	Off-Site	43	6
July	Perimeter	63	12
	Off-Site	69	11
August	Perimeter	48	11
	Off-Site	39	8
September	Perimeter	58	15
	Off-Site	39	11
October	Perimeter	41	10
	Off-Site	68	15
November	Perimeter	40	18
	Off-Site	45	21
December	Perimeter	36	16
	Off-Site	52	19
Annual	Perimeter	57 ± 10	14 ± 2
Summary	Off-Site	45 ± 9	12 ± 3
Dose(mrem)	Perimeter	(0.00014)	(1.64)
	Off-Site	(0.00011)	(1.33)

average radiation measurements for the on-site samples were less than the off-site samples as discussed above.

The annual average alpha and beta activities since 1985 are displayed in Figure 4.1. The elevated beta activity in 1986 was due to fallout from the Chernobyl incident. If the radionuclides attributed to the Chernobyl incident are subtracted from the annual beta average of 40 fCi/m^3, the net would be 27 fCi/m^3, very similar to the averages of the other years. Figure 4.2 presents the annual average concentrations of the two major gamma-ray–emitting radionuclides in air. The annual average beryllium-7 concentrations have decreased regularly since 1987, reached a minimum in 1991, increased until 1996, and have now decreased. The changes in the beryllium-7 air concentrations have been observed worldwide by the DOE Environmental Measurements Laboratory's Surface Air Sampling Program and are attributed to changes in solar activity.[14]

Samples for radiochemical analyses were collected at perimeter location 7I (Figure 1.1) and off the site in Downers Grove (Figure 1.2). Collections were made on polystyrene filters. The total air volume filtered for the monthly samples was approximately 20,000 m^3 (700,000 ft^3). Samples were ignited at 600°C (1,100°F) to remove organic matter and were prepared for analysis by vigorous treatment with hot hydrochloric, hydrofluoric, and nitric acids.

Plutonium and thorium were separated on an ion-exchange column, and the uranium was extracted from the column effluent. Following the extraction, the aqueous phase was analyzed for radiostrontium by a standard radiochemical procedure. The separated plutonium, thorium, and uranium fractions were electrodeposited and measured by alpha spectrometry. The chemical recoveries were monitored by adding known amounts of plutonium-242, thorium-229, and uranium-236 tracers prior to ignition. Because spectrometry cannot distinguish between plutonium-239 and plutonium-240, when plutonium-239 is mentioned in this report, the alpha activity due to the plutonium-240 isotope is also included. The results are given in Table 4.3.

The strontium-90 concentrations have decreased over the past several years; consequently, during 2002, all of the results were less than the detection limit of 10 aCi/m^3, except for one off-site result in January. Strontium-89 was not observed above the detection limit of 100 aCi/m^3. The plutonium-239 concentrations at all locations were similar to those of the last few years. The thorium and uranium concentrations were in the same range as in the past and are considered to be of natural origin. The amounts of thorium and uranium in a sample were proportional to the mass of inorganic material collected on the filter paper. The presence of most of these airborne elements can be attributed to the resuspension of soil.

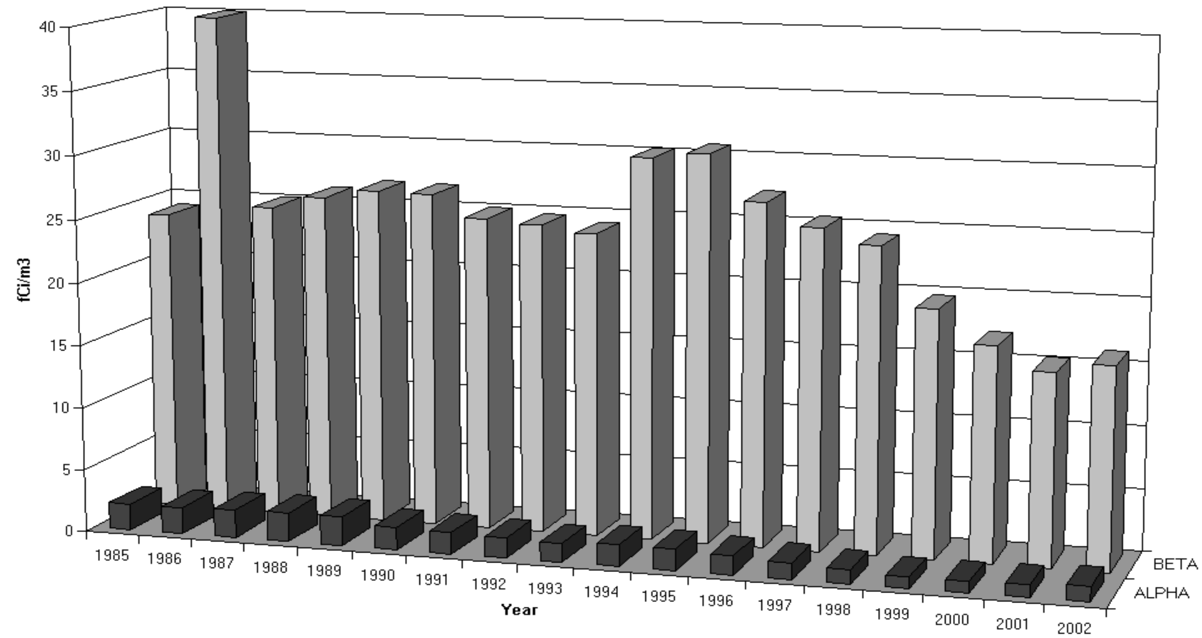


Figure 4.1 Comparison of Total Alpha and Beta Activities in Air Filter Samples

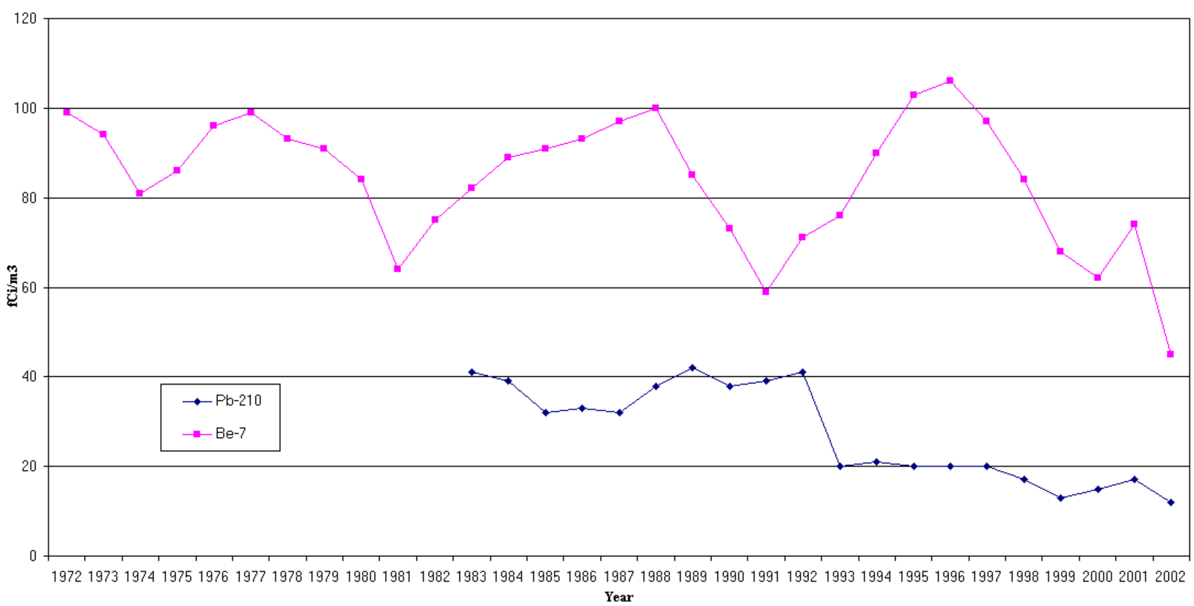


Figure 4.2 Comparison of Gamma-Ray Activity in the Air Filter Samples

TABLE 4.3

Strontium, Thorium, Uranium, and Plutonium Concentrations
in Air Filter Samples, 2002
(Concentrations in aCi/m^3)

Month	Location[a]	Strontium-90	Thorium-228	Thorium-230	Thorium-232	Uranium-234	Uranium-238	Plutonium-239
January	7I	< 10	2 ± 1	2 ± 1	< 1	2 ± 2	3 ± 1	0.3 ± 0.3
	Off-Site	12 ± 3	3 ± 1	2 ± 1	1 ± 1	3 ± 2	3 ± 1	0.2 ± 0.2
February	7I	< 10	3 ± 2	6 ± 1	3 ± 1	6 ± 2	7 ± 2	1.0 ± 0.6
	Off-Site	< 10	< 1	2 ± 1	< 1	2 ± 2	1 ± 1	0.2 ± 0.2
March	7I	< 10	8 ± 2	7 ± 2	5 ± 1	9 ± 2	10 ± 2	0.8 ± 0.4
	Off-Site	< 10	1 ± 1	2 ± 1	< 1	3 ± 2	3 ± 1	0.6 ± 0.3
April	7I	< 10	6 ± 2	6 ± 1	5 ± 1	8 ± 2	7 ± 1	0.3 ± 0.3
	Off-Site	< 10	2 ± 1	2 ± 1	1 ± 1	1 ± 2	4 ± 1	0.7 ± 0.4
May	7I	< 10	5 ± 2	6 ± 1	3 ± 1	8 ± 1	8 ± 1	0.5 ± 0.3
	Off-Site	< 10	1 ± 1	2 ± 1	< 1	2 ± 1	2 ± 1	1.9 ± 0.4
June	7I	< 10	4 ± 2	5 ± 1	4 ± 1	5 ± 1	7 ± 1	0.2 ± 0.4
	Off-Site	< 10	< 1	2 ± 1	< 1	3 ± 1	2 ± 1	0.3 ± 0.3
July	7I	< 10	8 ± 2	7 ± 2	7 ± 2	8 ± 2	9 ± 1	0.7 ± 0.3
	Off-Site	< 10	4 ± 1	3 ± 1	2 ± 1	4 ± 1	3 ± 1	0.7 ± 0.3
August	7I	< 10	7 ± 2	5 ± 2	4 ± 1	6 ± 2	8 ± 1	0.4 ± 0.3
	Off-Site	< 10	3 ± 1	2 ± 1	< 1	1 ± 1	3 ± 1	0.5 ± 0.2
September	7I	< 10	4 ± 1	7 ± 2	4 ± 1	8 ± 2	8 ± 2	1.3 ± 0.4
	Off-Site	< 10	1 ± 1	1 ± 1	< 1	2 ± 1	2 ± 1	0.3 ± 0.2
October	7I	< 10	6 ± 2	5 ± 1	4 ± 1	6 ± 2	7 ± 1	0.6 ± 0.3
	Off-Site	< 10	2 ± 1	1 ± 1	< 1	3 ± 2	2 ± 1	0.4 ± 0.2
November	7I	< 10	8 ± 2	10 ± 2	6 ± 2	14 ± 3	11 ± 2	0.4 ± 0.3
	Off-Site	< 10	< 1	1 ± 1	< 1	2 ± 1	3 ± 1	0.2 ± 0.2
December	7I	< 10	4 ± 1	6 ± 1	4 ± 1	9 ± 2	7 ± 1	0.3 ± 0.3
	Off-Site	< 10	1 ± 1	2 ± 1	1 ± 1	3 ± 2	3 ± 1	0.4 ± 0.2
Annual	7I	< 10	5 ± 5	6 ± 4	4 ± 4	7 ± 6	7 ± 4	0.6 ± 0.7
	Off-Site	< 10	2 ± 2	2 ± 1	< 1	2 ± 2	3 ± 2	0.5 ± 1.1
Dose	7I	< (0.00011)	(0.0137)	(0.0120)	(0.041)	(0.00037)	(0.00036)	(0.0014)
(mrem)	Off-Site	< (0.00011)	(0.0042)	(0.0036)	< (0.010)	(0.00011)	(0.00013)	(0.0013)

[a] Perimeter locations are given in terms of the grid coordinates in Figure 1.1.

The major airborne effluents released at ANL-E during 2002 are listed by location in Table 4.4; Figure 4.3 shows the annual releases of the major sources since 1985. The radon-220 releases from Building 200, due to radioactive contamination from the "proof-of-breeding" program conducted in the mid 1980s, have been greatly reduced. The hydrogen-3 emitted from Building 212 is from hydrogen-3 recovery studies, while short-lived neutron activation products are emitted from the IPNS and APS. In addition to the radionuclides listed in Table 4.4, several other fission products also were released in millicurie or smaller amounts. The quantities listed in Table 4.4 were measured by on-line stack monitors in the exhaust systems of the buildings, except those for Building 350.

TABLE 4.4

Summary of Airborne Radioactive Emissions from ANL-E Facilities, 2002

Building	Nuclide	Half-Life	Amount Released (Ci)	Amount Released (Bq)
200	Radon-220	56 s	29.7	1.1×10^{12}
205	Hydrogen-3 (tritiated water [HTO])	12.3 yr	0.19	6.9×10^{9}
212 (Alpha Gamma Hot Cell Facility)	Hydrogen-3 (HTO)	12.3 yr	9.18	3.4×10^{11}
	Hydrogen-3 (tritiated hydrogen gas [HT])	12.3 yr	91.8	3.4×10^{12}
	Krypton-85	10.7 yr	25.9	9.6×10^{11}
	Radon-220	56 s	0.41	1.5×10^{9}
350 (NBL)	Uranium-234	2.4×10^{5} yr	2.8×10^{-7}	1.0×10^{0}
	Uranium-238	4.5×10^{9} yr	2.8×10^{-7}	1.0×10^{0}
	Plutonium-238	87.7 yr	3.0×10^{-7}	1.1×10^{0}
	Plutonium-239	2.4×10^{4} yr	1.4×10^{-5}	5.2×10^{3}
	Plutonium-240	6.6×10^{4} yr	2.2×10^{-6}	8.1×10^{2}
	Plutonium-241	14.4 yr	6.7×10^{-6}	2.5×10^{2}
	Plutonium-242	3.8×10^{5} yr	1.0×10^{-8}	3.7×10^{-1}
375 (IPNS)	Carbon-11	20 m	1459.7	5.4×10^{13}
	Argon-41	1.8 h	94.4	3.5×10^{11}
411/415 (APS)	Carbon-11	20 m	0.15	5.5×10^{9}
	Nitrogen-13	10 m	10.90	4.0×10^{11}
	Oxygen-15	122 s	1.19	4.4×10^{10}

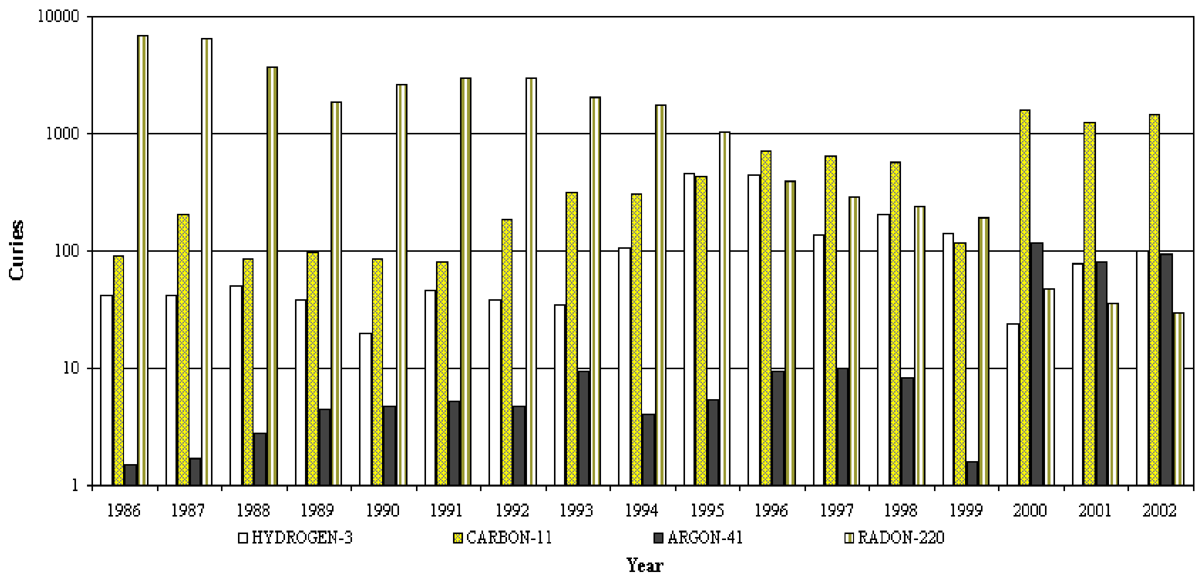


Figure 4.3 Selected Airborne Radionuclide Emissions

Phytoremediation is being applied to the 317/319 Area to complete the cleanup of the groundwater in the area, which was contaminated in the past by the disposal of liquid wastes to the soil in French drains. Phytoremediation is a natural process by which woody and herbaceous plants extract pore water and entrained chemical substances from subsurface soil, degrade volatile organic constituents, and transpire water vapor to the atmosphere. The system consists of planting shallow-rooted willow and special deep-rooted poplar trees. A mixture of grasses and legumes are also planted around the trees to address shallow soil contamination and to prevent soil erosion. Approximately 800 trees were planted in the fall of 1999.

One of the major groundwater contaminants in the 317/319 Area is hydrogen-3, as tritiated water. The phytoremediation process will translocate the hydrogen-3 from the groundwater to the air as water vapor. Since the hydrogen-3 is released over an area of approximately 2 ha (5.5 acres), traditional point source monitoring for airborne hydrogen-3 water vapor is of little value to determine the quantity of hydrogen-3 released to the air. The annual inventory of hydrogen-3 released to the air can be estimated from the hydrogen-3 content of the groundwater and the extraction rate at which various aged trees remove groundwater. On the basis of the age and type of tree, estimates are available on the average consumption rate of groundwater per tree per month of the growing season. For this estimate, it is assumed that all of the groundwater that is extracted is transpired.

Quarterly monitoring is conducted at the 18 wells that are within the phytoremediation plantation. The average hydrogen-3 concentration for 2002 for all the wells was 838 pCi/L. The annual amount of hydrogen-3 released is then the product of the annual volume of water released for all 800 trees multiplied by the hydrogen-3 concentration in the groundwater. For 2002, the total hydrogen-3 released was 0.01 Ci. Applying the CAP-88 code,[13] an estimate of the annual dose to the maximally exposed individual was 0.0000002 mrem. This estimated dose is extremely small compared with the 10 mrem annual dose limit of NESHAPs.

4.3. Surface Water

All water samples collected in the monitoring program were acidified to 0.1N with nitric acid and filtered immediately after collection. Total nonvolatile alpha and beta activities were determined by counting the residue remaining after evaporation of the water and then applying counting efficiency corrections determined for plutonium-239 (for alpha activity) and thallium-204 (for beta activity) to obtain disintegration rates. Hydrogen-3 was measured from a separate aliquot; this activity does not appear in the results for total nonvolatile beta activity. Analyses for the radionuclides were performed by specific radiochemical separations followed by appropriate counting. One-liter aliquots were used for all analyses except for hydrogen-3 and the transuranium nuclides. Hydrogen-3 analyses were performed by liquid scintillation counting of 9 mL (0.03 oz) of a distilled sample in a nonhazardous cocktail. Analyses for transuranium nuclides were performed on 10-L (3-gal) samples with chemical separation methods followed by alpha spectrometry. Plutonium-236 was used to determine the yields of plutonium and neptunium, which were separated from the sample together. A group separation of a fraction containing the transplutonium elements was monitored for recovery with an americium-243 tracer. Isotopic uranium concentrations were determined by alpha spectrometry by using uranium-236 as an isotopic tracer.

Liquid wastewater from buildings or facilities that use or process radioactive materials is collected in retention tanks. When a tank is full, it is sampled and analyzed for alpha and beta radioactivity. If the radioactivity exceeds the release limits, the tank is processed by evaporation and the residue is disposed of as solid LLW. If the radioactivity is below the release limits, the wastewater is conveyed to the laboratory WTP in dedicated pipes to waste storage tanks. The release limits are based on the DCGs for plutonium-239 (0.03 pCi/mL) for alpha activity, and for strontium-90 (1.0 pCi/mL) for beta activity. These radionuclides were selected because of their potential for release and their conservative allowable limits in the environment. The effluent monitoring program documents that no liquid releases above the DCGs have occurred and reinforces demonstration of compliance with the use of best available technology (BAT) as required by DOE Order 5400.5.[9]

Another component of the radiological effluent monitoring program, which was instituted in 1999, is the radiological analysis of the main water treatment plant discharge (Outfall 001). Metals have been analyzed at this location for a number of years (see Table 5.8). The same radiological constituents that are determined in Sawmill Creek are also analyzed at this location. Samples are collected daily, and equal portions are combined for each week and analyzed to obtain an average weekly concentration. Table 4.5 gives the results for 2002. The results show that the radionuclides

TABLE 4.5

Radionuclides in Effluents from the ANL-E Wastewater Treatment Plant, 2002

Activity	No. of Samples	Concentration (pCi/L)			Dose (mrem)		
		Avg.	Min.	Max.	Avg.	Min.	Max.
Alpha	52	0.8 ± 0.9	< 0.1	2.1	-[a]	-	-
Beta	52	12 ± 4	6	18	-	-	-
Hydrogen-3	52	< 100	< 100	175	< 0.0046	< 0.0046	0.0080
Strontium-90	52	0.48 ± 0.21	< 0.25	0.86	0.046	< 0.024	0.082
Cesium-137	52	< 2.0	< 2.0	2.4	< 0.07	< 0.07	0.09
Uranium-234	52	0.326 ± 0.352	0.105	0.784	0.062	0.020	0.149
Uranium-238	52	0.282 ± 0.320	0.071	0.693	0.047	0.012	0.116
Neptunium-237	52	< 0.0010	< 0.0010	0.0016	< 0.0028	< 0.0028	0.0045
Plutonium-238	52	< 0.0010	< 0.0010	0.0014	< 0.0028	< 0.0028	0.0039
Plutonium-239	52	< 0.0010	< 0.0010	0.0023	< 0.0031	< 0.0031	0.0072
Americium-241	52	0.0011 ± 0.0020	< 0.0010	0.0055	0.0035	< 0.0033	0.0180
Curium-242 and/or Californium-252	52	< 0.0010	< 0.0010	< 0.0010	< 0.0007	< 0.0007	<0.0007
Curium-244 and/or Californium-249	52	< 0.0010	< 0.0010	0.0016	< 0.0034	< 0.0034	0.0054

[a] A hyphen indicates no CEDEs for alpha and beta.

hydrogen-3 and possibly strontium-90 detected in the effluent water can be attributed to ANL-E operations. However, analysis of the ANL-E domestic water, which is obtained for Lake Michigan, indicates strontium-90 at about 0.4 pCi/L. This was confirmed by the direct analysis of Lake Michigan water. The concentrations are very low and a small fraction of the DOE limits; these findings reinforce ANL-E compliance with DOE Order 5400.5 for use of BAT for releases of liquid effluents. To estimate the total annual quantity of each radionuclide released to the environment, the product of the annual average concentration and the annual volume of water discharged (1.12×10^9 L) is computed. These results are given in Table 4.6.

ANL-E wastewater is discharged into Sawmill Creek (Location 7M in Figure 1.1). The creek runs through the ANL-E grounds, drains surface water from much of the site, and flows into the Des Plaines River about 500 m (1,600 ft) downstream from the ANL-E wastewater outfall. Sawmill Creek was sampled upstream from the ANL-E site and downstream from the wastewater discharge point to determine whether radioactivity was added to the stream by ANL-E wastewater or surface drainage. The sampling locations are shown in Figure 1.1. Daily samples were collected below the wastewater outfall. Equal portions of the daily samples collected each week were combined and analyzed to obtain an average weekly concentration. Samples were collected upstream of the site once a month and were analyzed for the same radionuclides measured in the below-outfall samples.

TABLE 4.6

Total Radioactivity Released, 2002

Radionuclide	WTP Outfall (Ci)
Hydrogen-3	0.10
Strontium-90	0.0005
Plutonium-239	<0.0001
Americium-241	<0.0001
Total	0.10

Table 4.7 gives the annual summaries of the results obtained for Sawmill Creek. Comparison of the results and 95% confidence levels of the averages for the two sampling locations shows that the following radionuclides found in the creek water can be attributed to ANL-E operations: hydrogen-3, strontium-90, neptunium-237, plutonium-238, plutonium-239, americium-241, and curium-244 and/or californium-249. The concentrations of all these nuclides are low and at a small fraction of DOE concentration limits. In Sawmill Creek, below the ANL-E outfall, the annual average concentrations of most measured radionuclides were similar to recent annual averages. All the annual averages were well below the applicable DOE standards.

On the basis of the results of the Storm Water Characterization Study (see Section 2.2.2), two perimeter surface water locations were identified that contained measurable levels of radionuclides. They were south of the 319 Area, Location 7J, and south of the 800 Area Landfill, Location 11D (see Figure 1.1). Samples were scheduled to be collected quarterly and analyzed for hydrogen-3, strontium-90, and gamma-ray emitters. The results are presented in Table 4.8.

The source of the radionuclides at Location 7J appears to be leachate from the 319 Area Landfill. A subsurface barrier wall and leachate collection system were constructed south of the 319 Landfill in November 1995 and became operational in 1996. Since the construction and operation of the leachate collection system, radionuclide concentrations in surface water at Location 7J have decreased substantially. The hydrogen-3 at Location 11D is probably also from the leachate; the decrease in the concentration from earlier years is due to the completion of the clay cap on the 800 Area Landfill in the fall of 1993.

One of the ANL-E waste management locations is within the 398A fenced area (Location 8J in Figure 1.1). Surface water drainage from this area is collected in a small pond at the south

TABLE 4.7

Radionuclides in Sawmill Creek Water, 2002

			Concentration (pCi/L)			Dose (mrem)		
Activity	Location[a]	No. of Samples	Avg.	Min.	Max.	Avg.	Min.	Max.
Alpha	16K	12	1.5 ± 2.1	0.3	3.7	-[b]	-	-
(Nonvolatile)	7M	51	1.0 ± 1.2	0.2	3.6	-	-	-
Beta	16K	12	8 ± 6	4	13	-	-	-
(Nonvolatile)	7M	51	9 ± 4	5	15	-	-	-
Hydrogen-3	16K	12	< 100	< 100	102	< 0.0046	< 0.0046	0.0047
	7M	51	< 100	< 100	307	< 0.0046	< 0.0046	0.0141
Strontium-90	16K	12	< 0.25	< 0.25	0.42	< 0.024	< 0.024	0.040
	7M	51	0.35 ± 0.19	< 0.25	0.71	0.033	< 0.024	0.067
Cesium-137	16K	12	< 2.0	< 2.0	< 2.0	< 0.07	< 0.07	< 0.07
	7M	51	< 2.0	< 2.0	< 2.0	< 0.07	< 0.07	< 0.07
Uranium-234	16K	12	0.832 ± 1.129	0.160	1.857	0.158	0.030	0.353
	7M	51	0.465 ± 0.512	0.130	1.063	0.088	0.025	0.202
Uranium-238	16K	11	0.740 ± 0.954	0.130	1.343	0.124	0.022	0.226
	7M	50	0.414 ± 0.474	0.093	0.963	0.070	0.016	0.162
Neptunium-237	16K	12	< 0.0010	< 0.0010	< 0.0010	< 0.0028	< 0.0028	< 0.0028
	7M	51	< 0.0010	< 0.0010	0.0015	< 0.0028	< 0.0028	0.0044
Plutonium-238	16K	12	< 0.0010	< 0.0010	0.0045	< 0.0028	< 0.0028	0.0125
	7M	51	< 0.0010	< 0.0010	0.0019	< 0.0028	< 0.0028	0.0053
Plutonium-239	16K	12	< 0.0010	< 0.0010	0.0054	< 0.0031	< 0.0031	0.0171
	7M	51	< 0.0010	< 0.0010	0.0028	< 0.0031	< 0.0031	0.0087
Americium-241	16K	12	0.0013 ± 0.0022	< 0.0010	0.0035	0.0043	< 0.0033	0.0115
	7M	51	0.0016 ± 0.0080	< 0.0010	0.0264	0.0053	< 0.0033	0.0869
Curium-242 and/or	16K	12	< 0.0010	< 0.0010	0.0028	< 0.0007	< 0.0007	0.0019
Californium-252	7M	51	< 0.0010	< 0.0010	< 0.0010	< 0.0007	< 0.0007	< 0.0007
Curium-244 and/or	16K	12	< 0.0010	< 0.0010	0.0014	< 0.0034	< 0.0034	0.0046
Californium-249	7M	51	< 0.0010	< 0.0010	0.0024	< 0.0034	< 0.0034	0.0081

[a] Location 16K is upstream from the ANL-E site, and location 7M is downstream from the ANL-E wastewater outfall.

[b] A hyphen indicates no CEDEs for alpha and beta.

TABLE 4.8

Radionuclides in Storm Water Outfalls, 2002
(concentrations in pCi/L)

Date Collected	Location 7J Hydrogen-3	Location 7J Strontium-90	Location 7J Cesium-137	Location 11D Hydrogen-3
03/08/02	<100	0.57	<2	188
04/08/02	<100	0.62	<2	324
08/22/02	<100	0.37	<2	<100
10/04/02	<100	0.43	<2	Dry

(downgradient) end of the 398A area. To evaluate whether any radionuclides are being transported by storm water flow through the 398A area, quarterly sampling is conducted from the 398A pond and analyzed for hydrogen-3 and gamma-ray–emitting radionuclides. All hydrogen-3 results were below the detection limit of 100 pCi/L and gamma-ray spectrometric analysis did not detect any radionuclides associated with ANL-E activities above the detection limit of 2 pCi/L.

Because Sawmill Creek empties into the Des Plaines River, data on the radioactivity in this river is important in assessing the contribution of ANL-E wastewater to environmental radioactivity. The Des Plaines River was sampled twice a month below and once a month above the mouth of Sawmill Creek to determine whether the radioactivity in the creek had any effect on the radioactivity in the river. Table 4.9 gives the annual summaries of the results obtained for these two locations. The average nonvolatile alpha, beta, and uranium concentrations in the river were very similar to past averages and remained in the normal range. Elevated concentrations of americium-241 were measured at both sampling locations. The americium-241 concentrations were higher than americium-241 concentrations in the ANL-E outfall water. The source of the americium-241 appears to be external to ANL-E. Except for the americium-241, results were similar above and below the creek for all radionuclides, because the activity in Sawmill Creek was reduced by dilution to the point that it was not detectable in the Des Plaines River.

4.4. Bottom Sediment

The radioactive content of bottom sediment was measured in Sawmill Creek. A grab sample technique was used to obtain bottom sediments. After drying, grinding, and mixing, portions of each of the bottom sediment samples were analyzed by the same methods described in Section 4.2 for air filter residues. The plutonium and americium were separated from the same 10-g (0.35-oz) aliquot of sediment. Results are given in terms of the oven-dried (110°C [230°F]) weight.

TABLE 4.9

Radionuclides in Des Plaines River Water, 2002

Activity	Location[a]	No. of Samples	Concentration (pCi/L) Avg.	Concentration (pCi/L) Min.	Concentration (pCi/L) Max.	Dose (mrem) Avg.	Dose (mrem) Min.	Dose (mrem) Max.
Alpha	A	12	1.1 ± 1.3	0.3	2.2	-[b]	-	-
(Nonvolatile)	B	24	1.0 ± 0.8	0.2	1.7	-	-	-
Beta	A	12	12 ± 8	5	18	-	-	-
(Nonvolatile)	B	24	12 ± 7	6	18	-	-	-
Hydrogen-3	A	12	< 100	< 100	< 100	< 0.0046	< 0.0046	< 0.0046
	B	24	< 100	< 100	122	< 0.0046	< 0.0046	0.0056
Strontium-90	A	12	< 0.25	< 0.25	0.26	< 0.024	< 0.024	0.025
	B	24	< 0.25	< 0.25	0.28	< 0.024	< 0.024	0.026
Uranium-234	A	12	0.525 ± 0.584	0.209	0.940	0.100	0.040	0.179
	B	24	0.521 ± 0.440	0.214	0.933	0.099	0.041	0.177
Uranium-238	A	11	0.458 ± 0.491	0.165	0.757	0.077	0.028	0.127
	B	23	0.448 ± 0.411	0.156	0.788	0.075	0.026	0.132
Neptunium-237	A	12	< 0.0010	< 0.0010	< 0.0010	< 0.0028	< 0.0028	< 0.0028
	B	12	< 0.0010	< 0.0010	0.0011	< 0.0028	< 0.0028	0.0032
Plutonium-238	A	12	< 0.0010	< 0.0010	< 0.0010	< 0.0028	< 0.0028	< 0.0028
	B	12	< 0.0010	< 0.0010	0.0015	< 0.0028	< 0.0028	0.0042
Plutonium-239	A	12	< 0.0010	< 0.0010	< 0.0010	< 0.0031	< 0.0031	< 0.0031
	B	12	< 0.0010	< 0.0010	< 0.0010	< 0.0031	< 0.0031	< 0.0031
Americium-241	A	12	0.0010 ± 0.0026	< 0.0010	0.0039	0.0033	< 0.0033	0.0129
	B	12	0.0046 ± 0.0185	< 0.0010	0.0282	0.0151	< 0.0033	0.0925
Curium-242 and/or	A	12	< 0.0010	< 0.0010	0.0018	< 0.0007	< 0.0007	0.0012
Californium-252	B	12	< 0.0010	< 0.0010	< 0.0010	< 0.0007	< 0.0007	< 0.0007
Curium-244 and/or	A	12	< 0.0010	< 0.0010	0.0021	< 0.0034	< 0.0034	0.0072
Californium-249	B	12	< 0.0010	< 0.0010	0.0070	< 0.0034	< 0.0034	0.0234

[a] Location A, near Willow Springs, is upstream; location B, near Lemont, is downstream from the mouth of Sawmill Creek. See Figure 1.2.

[b] A hyphen indicates no CEDEs for alpha and beta.

A set of sediment samples was collected on September 16, 2002, from the Sawmill Creek bed, above, at the outfall, and at several locations below the point at which ANL-E discharges its treated wastewater (Location 7M in Figure 1.1). The results, as listed in Table 4.10, show that the concentrations in the samples collected above the 7M outfall are similar to those of the off-site samples collected in past years.[15] The plutonium, americium, and cesium-137 concentrations are elevated below the outfall, which indicates that their origin is in ANL-E wastewater but significantly less than last year. Plutonium results varied widely among locations and were strongly dependent on the retentiveness of the bottom material. The changes in concentrations of these nuclides with time and location indicate the dynamic nature of the sediment material in this area.

4.5. External Penetrating Gamma Radiation

Levels of external penetrating gamma radiation at and in the vicinity of the ANL-E site were measured with aluminum oxide TLD chips provided and read by a commercial vendor. Each measurement reported represents the average of two chips exposed in the same packet. Dosimeters were exposed at 17 locations at the site boundary and on the site. Readings were also taken at five off-site locations (Figure 1.2) for comparative purposes. Three locations were added to the network in 1999 to monitor radioactive waste management activities. They are east of Building 306 (Location 9/10 I), south of Building 331 (Location 9 H/I), and next to the 398A radioactive waste storage area (Location 9J).

The results are summarized in Tables 4.11 and 4.12, and the site boundary and on-site readings are shown in Figure 4.4. Measurements were taken during the four successive exposure periods shown in the tables, and the results were calculated in terms of annual dose for ease in comparing measurements made for different elapsed times. The uncertainty of the averages given in the tables is the 95% confidence limit calculated from the standard deviation of the average.

The off-site results averaged 93 ± 4 mrem/yr and were substantially lower than last year's off-site average of 103 ± 6 mrem/yr.[16] To compare boundary results for individual sampling periods, the standard deviation of the 19 individual off-site results is useful. This value is 9 mrem/yr; thus, individual results in the range of 93 ± 18 mrem/yr may be considered to be the average natural background with a 95% probability.

The site boundary at Location 7I had dose rates consistently above the average background. This was the result of radiation from ANL-E's 317 Area in the northern half of grid 7I. Waste was packaged and temporarily stored in this area before removal for permanent disposal off site. In 2002, the dose at this perimeter fence location was 111 ± 11 mrem/yr. Approximately 300 m (960 ft) south of the fence in grid 6I, the measured dose dropped to 103 ± 7 mrem/yr, which is within the normal background range.

TABLE 4.10

Radionuclides in Bottom Sediment, 2002

Location	Potassium-40	Cesium-137	Radium-226	Thorium-228	Thorium-232	Plutonium-238	Plutonium-239	Americium-241
	Concentration (pCi/g)					Concentration (fCi/g)		
Sawmill Creek 25 m above outfall	7.50 ± 0.43	< 0.01	0.48 ± 0.05	0.33 ± 0.03	0.25 ± 0.06	0.3 ± 0.3	0.7 ± 0.4	0.8 ± 0.4
Sawmill Creek at outfall	16.95 ± 0.57	0.06 ± 0.02	1.00 ± 0.06	0.72 ± 0.04	0.50 ± 0.07	0.3 ± 0.3	22.0 ± 2.5	4.4 ± 1.2
Sawmill Creek 50 m below outfall	14.60 ± 0.54	0.02 ± 0.02	0.80 ± 0.05	0.71 ± 0.04	0.62 ± 0.07	0.6 ± 0.3	1.2 ± 0.5	0.6 ± 0.4
Sawmill Creek 100 m below outfall	12.09 ± 0.51	0.08 ± 0.02	0.59 ± 0.05	0.48 ± 0.04	0.37 ± 0.07	0.4 ± 0.3	6.3 ± 1.2	1.9 ± 0.7
Sawmill Creek at Des Plaines River	14.11 ± 0.53	< 0.01	0.77 ± 0.05	0.77 ± 0.04	0.60 ± 0.07	< 0.1	0.7 ± 0.4	1.4 ± 0.6

TABLE 4.11

Environmental Penetrating Gamma Radiation at Off-Site Locations, 2002

	Dose Rate (mrem/yr) Period of Measurement				
Location	Jan. 3–April 1	April 1–July 2	July 2–Oct. 1	Oct. 1–Jan. 2	Average
Lemont	86	100	94	97	94 ± 6
Clarendon Hills	94	100	103	98	99 ± 4
Orland Park	76	85	76	-[a]	79 ± 5
Woodridge	101	97	90	117	101 ± 11
Willow Springs	85	95	87	83	88 ± 5
Average	88 ± 8	95 ± 6	90 ± 9	99 ± 13	93 ± 4

[a] A hyphen indicates an invalid sample.

In the past, an elevated on-site dose had been measured at Location 9H, next to the CP-5 reactor, where irradiated hardware from the reactor was stored. During the past few years, considerable cleanup of the CP-5 reactor yard has occurred as part of the CP-5 reactor D&D project. The dose at Location 9H decreased from about 1,200 mrem/yr in 1989 to 100 mrem/yr in 2002.

The three new locations were added to monitor radioactive waste facilities and areas. Significant movement of radioactive waste took place, principally waste from the D&D of the CP-5 reactor and the relocation of radioactive waste from the 317 Area to the 398A Area. Some waste is repacked in Building 306 (Location 9/10 I). The dose from these operations was above normal background levels. The elevated dose levels in the 398A Area (Location 9J) are from waste relocated from the 317 Area, historic waste, and D&D waste temporarily stored pending shipment. The Building 331 yard (Location 9 H/I) is being used as a staging area to load trucks for shipment off site. A number of radioactive waste shipments were made during 2002, as reflected by the elevated dose rates. The 398A Area was also used as a staging area to load trucks for shipment off site. Depending on the number of shipments, the dose rates will vary from quarter to quarter.

4.6. Neutron Monitoring

An environmental fast neutron monitoring program was established in 2002. Although ANL-E does not have any operating nuclear reactors, several facilities produce fast neutrons and have the potential to release these to the environment. To estimate the dose to the environment during normal operation of these facilities, one of these facilities, the IPNS, was selected for monitoring.

TABLE 4.12

Environmental Penetrating Gamma Radiation at ANL-E, 2002

Location[a]	Dose Rate (mrem/yr) Period of Measurement Jan. 3–April 1	April 1–July 2	July 2–Oct. 1	Oct. 1–Jan. 2	Average
14G - Boundary	103	102	104	102	103 ± 1
14I - Boundary	89	96	86	87	89 ± 4
14L - Boundary	96	101	94	97	97 ± 3
6I - 200 m N of Quarry Road	94	106	110	103	103 ± 7
7I - Center, Waste Storage Area Facility 317	325	290	220	185	255 ± 63
7I - Boundary	106	127	107	105	111 ± 11
8H - Boundary	91	99	95	98	96 ± 4
8H - 65 m S of Building 316	97	108	95	96	99 ± 6
8H - 200 m NW of Waste Storage Area (Heliport)	98	105	97	94	99 ± 5
8H - Boundary, Center, St. Patrick Cemetery	95	113	93	102	100 ± 9
9H - 50 m SE of CP-5	92	105	101	100	100 ± 5
9 H/I - 50 m E of Building 331	559	1160	1000	1150	967 ± 276
9/10 I - E of D306	804	212	217	163	349 ± 298
9/10 I - 65 m NE of Building 350, 230 m NE of Building 316	99	107	95	101	100 ± 5
9/10 EF - Boundary	98	106	110	101	104 ± 5
9J - 50 m W of 398A Area	725	808	726	680	735 ± 52
10/11 K - Lodging Facilities	85	94	86	86	88 ± 4

[a] See Figure 1.1.

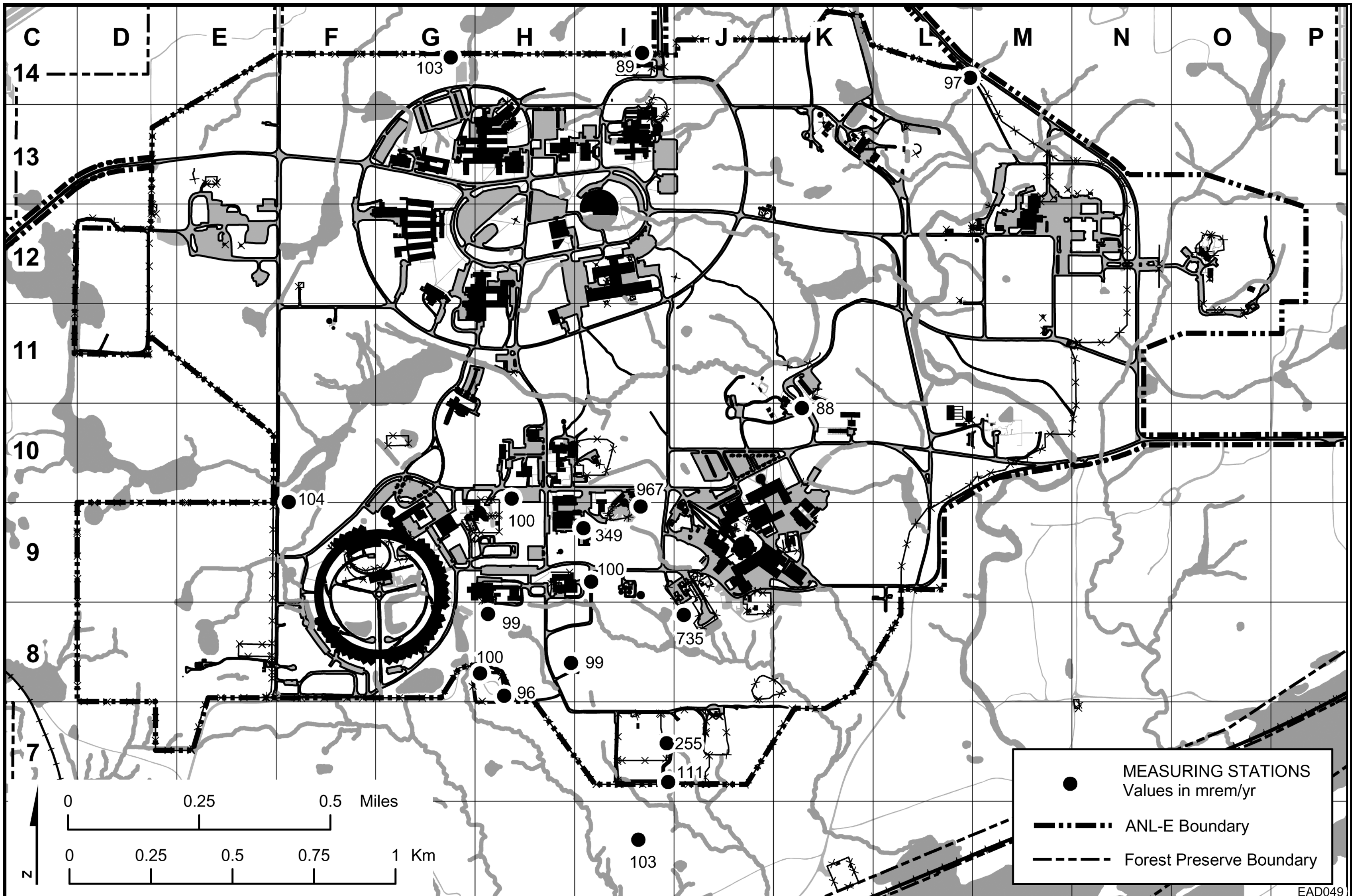


Figure 4.4 Penetrating Radiation Measurements at the ANL-E Site, 2002

The IPNS produces up to several hundred MeV neutrons for experimental work. Pulses of high-energy protons from an accelerator system are directed by magnets contained in a heavily shielded beamline enclosure into the target area. The target consists of depleted uranium discs contained within stainless-steel housing. The target is cooled by water. The neutron-generating facilities and target support systems are encased within a biological shield that provides structural support and shielding of steel and concrete. Air emissions from this facility are discussed in Section 4.7.1.

Beginning in January 2002, four environmental neutron monitors were obtained from a commercial vendor and placed at locations that were most likely to result in neutron dose. A fifth dosimeter was placed at an off-site location to monitor background neutron dose in areas uneffected by ANL-E operations. The neutron dosimeters were changed quarterly. The results are given in Table 4.13 and shown in Figure 4.5. The second quarter results are not available since the vendor provided the wrong type of dosimeter for that time period.

The results are expressed in units of dose (mrem) for the time the dosimeter was in the field. Therefore, the annual dose is the sum of the individual measurements but excludes any estimate of the possible dose during the second quarter. Because IPNS does not operate continuously, there may be time periods of up to a month when the system is not generating neutrons. The monitored locations are outside but near to the facility. Although these areas are not continuously occupied, measurements in 2002 indicated the potential for neutron dose. Any nearby workers would receive a significantly lower dose, and the dose to the fence line is estimated to be less than 0.01 mrem. The program at IPNS will continue in 2003, and a similar neutron monitoring network will be established at the ATLAS facility.

TABLE 4.13

Fast Neutron Dose at ANL-E, 2002
(Dose for Measurement Period in mrem)

	Period of Measurement				
On-Site Location	Jan 3–Apr 1	Apr 1–July 2	July 2–Oct 1	Oct 1–Jan 2	Total
60 m NE of Building 375	60	a	70	90	220
30 m NW of Building 375	50	a	35	70	155
45 m SW of Building 375	30	a	35	50	115
60 m S of Building 375	20	a	15	30	65
Off-Site Location					
Woodridge	< 1	a	< 1	< 1	< 1

[a] Invalid sample.

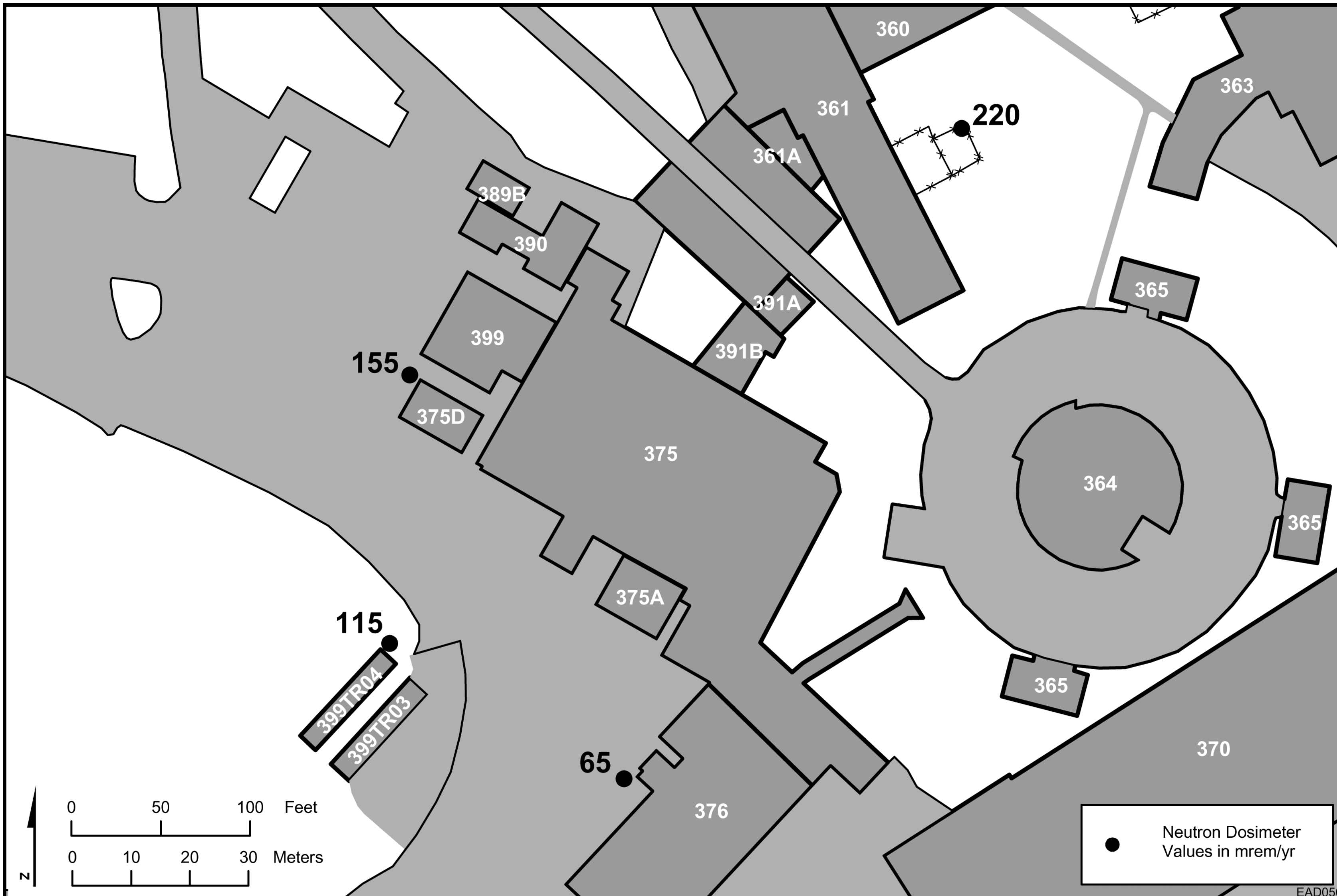


Figure 4.5 Neutron Dose Measurements, 2002

4.7. Estimates of Potential Radiation Doses

The radiation doses at the site boundary and off the site that could have been received by the public from radioactive materials and radiation leaving the site were calculated. Calculations were performed for three exposure pathways — airborne, water, and direct radiation from external sources.

4.7.1. Airborne Pathway

DOE facilities with airborne releases of radioactive materials are subject to 40 CFR Part 61, Subpart H,[17] which requires the use of the EPA's Clean Air Act Assessment Package-1988 (CAP-88) code[13] to calculate the dose for radionuclides released to the air and to demonstrate compliance with the regulation. The dose limit applicable for 2002 for the air pathway is a 10-mrem/yr effective dose equivalent. The CAP-88 computer code uses a modified Gaussian plume equation to estimate both horizontal and vertical dispersion of radionuclides released to the air from stacks or area sources. For 2002, doses were calculated for hydrogen-3, carbon-11, nitrogen-13, oxygen-15, argon-41, krypton-85, radon-220 plus daughters, and a number of actinide radionuclides. The annual releases are those listed in Table 4.4; separate calculations were performed for each of the six release points. The wind speed and direction data shown in Figure 1.3 were used for these calculations. In the past, the wind stability classes had been determined by the temperature differences between the 10-m (33-ft) and 60-m (197-ft) levels. To improve the determination of stability levels, the categories were obtained from daytime measurements of solar radiation and nighttime measurements of the standard deviation of the horizontal wind speed. Doses were calculated for an area extending out to 80 km (50 mi) from ANL-E. The population distribution of the 16 compass segments and 10 distance increments given in Table 1.1 was used. The dose rate was calculated at the midpoint of each interval and integrated over the entire area to give the annual population cumulative dose.

Distances from the specific facilities that exhaust radiological airborne emissions (see Table 4.4) to the fence line (perimeter) and nearest resident were determined in the 16 compass segments. Calculations also were performed to evaluate the major airborne pathways — ingestion, inhalation, and immersion — both at the point of maximum perimeter exposure and to the maximally exposed resident. The perimeter and resident doses and the maximum doses are listed, respectively, for releases from Buildings 200 (Tables 4.14 and 4.15), Building 205 (Tables 4.16 and 4.17), Building 212 (Tables 4.18 and 4.19), Building 350 (Tables 4.20 and 4.21), Building 375 (Tables 4.22 and 4.23), and Building 411 (Tables 4.24 and 4.25). The doses given in these tables are the committed whole body effective dose equivalents.

A significant D&D program was completed in 1995 for the M-Wing hot cells in Building 200, which constituted the source of the radon-220 emissions. Cleanup of the major source of the radon-220, cell M-1, resulted in a decrease of radon-220 emissions from 3,000 Ci in 1992 to

TABLE 4.14

Radiological Airborne Releases from Building 200, 2002

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	500	5.9×10^{-3}	1,000	1.6×10^{-3}
NNE	600	5.3×10^{-3}	1,100	1.7×10^{-3}
NE	750	3.6×10^{-3}	2,600	3.5×10^{-4}
ENE	1,700	7.7×10^{-4}	3,100	2.7×10^{-4}
E	2,400	3.5×10^{-4}	3,500	1.9×10^{-4}
ESE	2,200	3.4×10^{-4}	3,600	1.5×10^{-4}
SE	2,100	2.9×10^{-4}	4,000	9.6×10^{-5}
SSE	2,000	4.5×10^{-4}	4,000	1.4×10^{-4}
S	1,500	5.2×10^{-4}	4,000	1.1×10^{-4}
SSW	1,000	1.7×10^{-3}	2,500	3.4×10^{-4}
SW	800	2.9×10^{-3}	2,200	6.5×10^{-4}
WSW	1,100	7.5×10^{-4}	1,500	4.3×10^{-4}
W	750	2.0×10^{-3}	1,500	5.8×10^{-4}
WNW	800	1.1×10^{-3}	1,300	4.7×10^{-4}
NW	600	2.0×10^{-3}	1,100	6.7×10^{-4}
NNW	600	2.9×10^{-3}	800	1.7×10^{-3}

[a] Source term: radon-220 = 29.7 Ci (plus daughters).

193 Ci in 1999. The radon-220 emissions were reduced further in 1999, to the present 29.7 Ci, because of the termination of the nuclear medical program that separates radium-224 from the thorium-228 parent and continued D&D of other cells.

The doses from each of the CAP-88 dose assessments were combined on the basis of the assumption that the CP-5 reactor is the central emission point for the site. The 16 compass directions from CP-5 were established for each perimeter and actual resident location. The six individual building assessments were then overlayed on the CP-5 grid, and the estimated dose was summed according to which values fell within the CP-5 segments. This approach provides an estimated dose to an actual individual and is not just the sum of the maximum doses from the individual building runs.

TABLE 4.15

Maximum Perimeter and Individual Doses
from Building 200 Air Emissions, 2002
(dose in mrem/yr)

Pathway	Perimeter (500 m N)	Individual (800 m NNW)
Ingestion	8.2×10^{-15}	3.0×10^{-15}
Inhalation	5.9×10^{-3}	1.7×10^{-3}
Air immersion	4.1×10^{-5}	1.1×10^{-5}
Ground surface	2.8×10^{-6}	1.0×10^{-6}
Total	5.9×10^{-3}	1.7×10^{-3}
Radionuclide		
Thallium-208	3.6×10^{-5}	9.3×10^{-6}
Bismuth-212	6.8×10^{-4}	2.3×10^{-4}
Lead-212	3.4×10^{-3}	1.2×10^{-3}
Radon-220	1.8×10^{-3}	2.8×10^{-4}
Total	5.9×10^{-3}	1.7×10^{-3}

The highest perimeter dose was in the east direction, with a maximum value of 0.38 mrem/yr (Location 9L in Figure 1.1). Essentially all of this dose can be attributed to air immersion of carbon-11 from the IPNS facility. The maximum perimeter dose is the same as last year and is due to carbon-11 emissions from the IPNS. The programmatic need for continued operation of the facility will result in continued releases of carbon-11.

The full-time resident who would receive the largest annual dose (0.039 mrem/yr), if he or she were outdoors during the entire year, is located approximately 2.5 km (1.6 mi) ENE of the IPNS facility. The major contributor to the whole body dose is the air immersion dose from carbon-11 (0.035 mrem/yr). Releases of radon-220 plus daughters contribute less than one percent of the resident dose. If radon-220 plus daughters were excluded from the calculation, the NESHAP reportable dose to the maximally exposed individual would be 0.039 mrem/yr.

The individual doses to the maximally exposed member of the public and the maximum fence line dose are shown in Figure 4.6. The decreases in individual and population doses from 1988 to 1999 are due in part to the decrease of radon-220 emissions as a result of the cleanup of the

TABLE 4.16

Radiological Airborne Releases from Building 205, 2002

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	850	7.1×10^{-6}	1,300	3.5×10^{-6}
NNE	1,000	6.7×10^{-6}	2,100	1.9×10^{-6}
NE	1,200	5.0×10^{-6}	2,700	1.3×10^{-6}
ENE	2,400	1.6×10^{-6}	3,000	1.1×10^{-6}
E	2,200	1.6×10^{-6}	2,400	7.7×10^{-7}
ESE	2,000	1.5×10^{-6}	3,500	6.0×10^{-7}
SE	1,800	1.5×10^{-6}	3,900	4.3×10^{-7}
SSE	1,500	2.9×10^{-6}	4,000	5.7×10^{-7}
S	1,300	2.6×10^{-6}	3,900	4.5×10^{-7}
SSW	1,100	5.4×10^{-6}	2,400	1.5×10^{-6}
SW	900	1.1×10^{-5}	2,100	4.0×10^{-6}
WSW	1,100	2.7×10^{-6}	1,800	1.2×10^{-6}
W	1,300	2.3×10^{-6}	1,800	1.7×10^{-6}
WNW	1,100	2.4×10^{-6}	1,700	1.2×10^{-6}
NW	1,100	2.6×10^{-6}	1,500	1.6×10^{-6}
NNW	900	4.8×10^{-6}	1,500	2.1×10^{-6}

[a] Source term: hydrogen-3 = 0.19 Ci.

Building 200 M-Wing hot cells. The increase from 1999 to 2002 is principally due to increased emissions from the IPNS.

The population data in Table 1.1 were used to calculate the cumulative population dose from airborne radioactive effluents from ANL-E operations. The results are given in Table 4.26, along with the natural external radiation dose. The natural radiation dose listed is the product of the 80-km (50-mi) population and the natural radiation dose of 300 mrem/yr.[18] It is assumed that this dose is representative of the entire area within an 80-km (50-mi) radius. The population dose resulting from ANL-E operations since 1987 is shown in Figure 4.7.

The potential radiation exposures by the inhalation pathways also were calculated by the methodology specified in DOE Order 5400.5.[9] The total quantity for each radionuclide inhaled, in microcuries (µCi), is calculated by multiplying the annual average air concentrations by the general public breathing rate of 8,400 m^3/yr.[19] This annual intake is then multiplied by the CEDE conversion

TABLE 4.17

Maximum Perimeter and Individual Doses from
Building 205 Air Emissions, 2002
(dose in mrem/yr)

Pathway	Perimeter (900 m SW)	Individual (2,100 m SW)
Ingestion	2.6×10^{-6}	9.4×10^{-7}
Inhalation	8.3×10^{-6}	3.0×10^{-6}
Air immersion	-[a]	-
Ground surface	-	-
Total	1.1×10^{-5}	4.0×10^{-6}
Radionuclide		
Hydrogen-3	1.1×10^{-5}	4.0×10^{-6}

[a] A hyphen indicates no exposure by this pathway.

factor for the appropriate lung retention class.[9] The CEDE conversion factors are in units of rem/μCi and this calculation gives the 50-year CEDE. Table 4.27 lists the applicable CEDE factors.

The calculated doses in Tables 4.1 and 4.2 were derived by using this procedure. Because they are all essentially at perimeter locations, these doses represent the fence-line values for those radionuclides measured. These doses are the same as the off-site measurements and represent the ambient dose for the area from these nuclides. No doses were calculated for the total alpha and total beta measurements because the guidance does not provide CEDE conversion factors for such measurements.

An evaluation was conducted for potential sensitive receptors of ANL-E airborne releases. One example includes children at the Argonne Child Care Center (Location 120 in Figure 1.1). The airborne dose from ANL-E is estimated to be about 0.07 mrem/yr at this location. This assumes full-time, outdoor exposure. Assuming that the children are present about eight hours per day, five days per week, the actual dose is closer to 0.02 mrem/yr. Additional potential sensitive receptors are located at the Darien school on 91st St., west of Rt. 83. The estimated full-time, outdoor dose at this location is about 0.01 mrem/yr. Again, assuming that the children are only present at this location six hours per day, five days per week, and for 35 weeks a year, the actual dose is closer to 0.001 mrem/yr.

TABLE 4.18

Radiological Airborne Releases from Building 212, 2002

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	800	3.9×10^{-3}	2,000	9.2×10^{-4}
NNE	1,000	3.4×10^{-3}	2,500	7.9×10^{-4}
NE	1,300	2.3×10^{-3}	2,000	1.2×10^{-3}
ENE	1,500	1.9×10^{-3}	2,500	8.3×10^{-4}
E	1,600	1.4×10^{-3}	2,800	5.8×10^{-4}
ESE	1,200	1.9×10^{-3}	2,500	5.7×10^{-4}
SE	1,400	1.2×10^{-3}	3,500	2.7×10^{-4}
SSE	1,400	1.7×10^{-3}	4,500	2.7×10^{-4}
S	1,500	1.0×10^{-3}	5,000	1.7×10^{-4}
SSW	1,600	1.5×10^{-3}	5,000	2.6×10^{-4}
SW	1,400	2.2×10^{-3}	2,400	1.1×10^{-3}
WSW	1,300	1.1×10^{-3}	2,300	4.3×10^{-4}
W	1,700	9.6×10^{-4}	2,200	6.4×10^{-4}
WNW	1,500	7.3×10^{-4}	2,000	4.7×10^{-4}
NW	1,300	9.9×10^{-4}	2,000	5.1×10^{-4}
NNW	1,000	2.0×10^{-3}	2,000	6.8×10^{-4}

[a] Source terms:

hydrogen-3 (HT)	=	91.8 Ci
hydrogen-3 (HTO)	=	9.18 Ci
krypton-85	=	25.93 Ci
antimony-125	=	4.8×10^{-4} Ci
iodine-125	=	3.2×10^{-6} Ci
iodine-129	=	2.0×10^{-5} Ci
cesium-134	=	6.6×10^{-6} Ci
cesium-137	=	1.6×10^{-4} Ci
cerium-144	=	4.0×10^{-8} Ci
europium-154	=	8.5×10^{-7} Ci
europium-155	=	3.3×10^{-7} Ci
radon-220	=	0.41 Ci
plutonium-238	=	4.7×10^{-7} Ci
plutonium-239	=	3.7×10^{-8} Ci
americium-241	=	1.0×10^{-7} Ci
curium-242	=	5.9×10^{-9} Ci
curium-244	=	1.1×10^{-6} Ci.

TABLE 4.19

Maximum Perimeter and Individual Doses
from Building 212 Air Emissions, 2002
(dose in mrem/yr)

Pathway	Perimeter (800 m N)	Individual (2,000 m NE)
Ingestion	8.9×10^{-4}	2.6×10^{-4}
Inhalation	2.9×10^{-3}	8.6×10^{-4}
Air immersion	7.9×10^{-6}	2.3×10^{-6}
Ground surface	1.0×10^{-4}	3.4×10^{-5}
Total	3.9×10^{-3}	1.2×10^{-3}
Radionuclide		
Hydrogen-3	3.1×10^{-3}	1.1×10^{-3}
Krypton-85	1.2×10^{-5}	3.4×10^{-6}
Antimony-125	7.7×10^{-5}	2.6×10^{-5}
Iodine-125	2.4×10^{-7}	6.2×10^{-8}
Iodine-129	4.8×10^{-5}	1.3×10^{-5}
Cesium-134	3.0×10^{-6}	1.0×10^{-6}
Cesium-137	2.8×10^{-6}	8.9×10^{-7}
Cerium-144	3.5×10^{-9}	1.0×10^{-9}
Europium-154	1.1×10^{-6}	3.6×10^{-7}
Europium-155	1.7×10^{-8}	5.6×10^{-9}
Radon-220	6.3×10^{-6}	2.0×10^{-7}
Plutonium-238	3.3×10^{-5}	9.6×10^{-6}
Plutonium-239	2.8×10^{-6}	8.1×10^{-7}
Americium-241	1.2×10^{-5}	3.5×10^{-6}
Curium-242	2.3×10^{-8}	6.8×10^{-9}
Curium-244	6.9×10^{-5}	2.0×10^{-5}
Total	3.9×10^{-3}	1.2×10^{-3}

TABLE 4.20

Radiological Airborne Releases from Building 350, 2002

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	1700	3.2×10^{-4}	2200	2.2×10^{-4}
NNE	1800	3.6×10^{-4}	3200	1.5×10^{-4}
NE	2200	2.8×10^{-4}	3100	1.7×10^{-4}
ENE	2000	3.1×10^{-4}	3100	1.7×10^{-4}
E	1700	3.3×10^{-4}	2500	1.5×10^{-4}
ESE	900	6.6×10^{-4}	3000	1.2×10^{-4}
SE	900	5.0×10^{-4}	3000	1.1×10^{-4}
SSE	700	9.8×10^{-4}	2700	1.6×10^{-4}
S	600	5.3×10^{-4}	2700	1.0×10^{-4}
SSW	400	1.2×10^{-3}	2500	2.0×10^{-4}
SW	600	1.3×10^{-3}	2700	1.9×10^{-4}
WSW	800	4.9×10^{-4}	2100	1.4×10^{-4}
W	900	5.1×10^{-4}	2200	1.6×10^{-4}
WNW	1000	2.7×10^{-4}	2100	1.0×10^{-4}
NW	1900	1.3×10^{-4}	2400	9.7×10^{-5}
NNW	1900	1.9×10^{-4}	2200	1.6×10^{-4}

[a] Source terms:
uranium-234 = 2.8×10^{-7} Ci
uranium-238 = 2.8×10^{-7} Ci
plutonium-238 = 3.0×10^{-7} Ci
plutonium-239 = 1.4×10^{-5} Ci
plutonium-240 = 2.2×10^{-6} Ci
plutonium-241 = 6.7×10^{-6} Ci
plutonium-242 = 1.0×10^{-8} Ci.

4.7.2. Water Pathway

Following the methodology outlined in DOE Order 5400.5,[9] the annual intake of radionuclides (in µCi) ingested with water is obtained by multiplying the concentration of radionuclides in microcuries per milliliter (µCi/mL) by the average annual water consumption of a member of the general public (7.3×10^5 mL). This annual intake is then multiplied by the CEDE conversion factor for ingestion (Table 4.27) to obtain the dose received in that year. This procedure was carried out for all radionuclides, and the individual results were summed to obtain the total ingestion dose.

TABLE 4.21

Maximum Perimeter and Individual Doses
from Building 350 Air Emissions, 2002
(dose in mrem/yr)

Pathway	Perimeter (600 m SW)	Individual (2,200 m N)
Ingestion	1.4×10^{-5}	2.3×10^{-6}
Inhalation	1.2×10^{-3}	2.1×10^{-4}
Air immersion	1.9×10^{-13}	3.3×10^{-14}
Ground surface	3.9×10^{-8}	6.8×10^{-9}
Total	1.3×10^{-3}	2.2×10^{-4}
Radionuclide		
Uranium-234	8.1×10^{-6}	1.4×10^{-6}
Uranium-238	7.2×10^{-6}	1.2×10^{-6}
Plutonium-238	2.1×10^{-5}	3.6×10^{-6}
Plutonium-239	1.0×10^{-3}	1.8×10^{-4}
Plutonium-240	1.6×10^{-4}	2.8×10^{-5}
Plutonium-241	7.7×10^{-6}	1.3×10^{-6}
Plutonium-242	7.1×10^{-7}	1.2×10^{-7}
Total	1.3×10^{-3}	2.2×10^{-4}

The only significant location where radionuclides attributable to ANL-E operations could be found in off-site water was Sawmill Creek below the wastewater outfall (see Table 4.7). Although this water is not used for drinking purposes, the 50-year effective dose equivalent was calculated for a hypothetical individual ingesting water at the radionuclide concentrations measured at that location. Those radionuclides added to Sawmill Creek by ANL-E wastewater, their net concentrations in the creek, and the corresponding dose rates (if water at these concentrations was used as the sole water supply by an individual) are given in Table 4.28. The dose rates were all well below the standards for the general population. It should be emphasized that Sawmill Creek is not used for drinking, swimming, or boating. Inspection of the area shows that there are fish in the stream; however, they do not constitute a significant source of food for any individual. Figure 4.8 is a plot showing the estimated dose a hypothetical individual would receive if ingesting Sawmill Creek water since 1986.

TABLE 4.22

Radiological Airborne Releases from Building 375 (IPNS), 2002

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	1,600	6.9×10^{-2}	3,200	1.9×10^{-2}
NNE	1,700	8.6×10^{-2}	3,100	2.5×10^{-2}
NE	1,700	8.7×10^{-2}	2,700	3.3×10^{-2}
ENE	1,500	9.7×10^{-2}	2,500	3.8×10^{-2}
E	600	3.8×10^{-1}	2,500	3.5×10^{-2}
ESE	600	3.3×10^{-1}	2,500	2.7×10^{-2}
SE	600	2.4×10^{-1}	2,500	1.8×10^{-2}
SSE	600	3.7×10^{-1}	3,000	2.0×10^{-2}
S	800	1.4×10^{-1}	3,000	1.4×10^{-2}
SSW	800	2.5×10^{-1}	3,500	1.7×10^{-2}
SW	800	2.6×10^{-1}	4,000	1.5×10^{-2}
WSW	1,500	4.4×10^{-2}	2,700	1.4×10^{-2}
W	2,200	3.1×10^{-2}	2,700	1.9×10^{-2}
WNW	1,500	3.4×10^{-2}	2,600	1.2×10^{-2}
NW	2,200	1.9×10^{-2}	2,500	1.5×10^{-2}
NNW	1,800	3.9×10^{-2}	2,200	2.7×10^{-2}

[a] Source terms: carbon-11 = 1459.7 Ci
argon-41 = 94.4 Ci.

As indicated in Table 4.7, occasional Sawmill Creek samples (fewer than 10%) contained traces of cesium-137, plutonium-238, curium-242 and 244, or californium-249 and 252; however, the averages were only slightly greater than the detection limit. The annual dose to an individual consuming water at these concentrations can be calculated with the same method used for those radionuclides more commonly found in creek water; this method of averaging, however, probably overestimates the true concentration. Annual doses range from 3×10^{-4} to 6×10^{-6} mrem/yr for these radionuclides.

DOE Order 5400.5[9] requires an evaluation of the dose to aquatic organisms from liquid effluents. The dose limit is 1 rad/day or 365 rad/yr. The location that could result in the highest dose to aquatic organisms is in Sawmill Creek downstream of the point where ANL-E discharges its treated wastewater. Inspection of the creek at this location indicates the presence of small bluegill and carp (about 100 g [4 oz] each). The aquatic dose assessment of these species was conducted

TABLE 4.23

Maximum Perimeter and Individual Doses from Building 375 (IPNS) Air Emissions, 2002 (dose in mrem/yr)

Pathway	Perimeter (600 m E)	Individual (2,500 m ENE)
Ingestion	-[a]	-
Inhalation	1.6×10^{-2}	1.5×10^{-3}
Air immersion	3.5×10^{-1}	3.5×10^{-2}
Ground surface	1.3×10^{-2}	1.6×10^{-3}
Total	3.8×10^{-1}	3.8×10^{-2}
Radionuclide		
Carbon-11	3.5×10^{-1}	3.5×10^{-2}
Argon-41	2.9×10^{-2}	3.4×10^{-3}
Total	3.8×10^{-1}	3.8×10^{-2}

[a] A hyphen indicates no exposure by this pathway.

using the DOE Technical Standard, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*.[20] The assessment used the general screening approach, which compares maximum water and sediment radionuclide concentrations with biota concentration guides (BCGs). Maximum water concentrations for hydrogen-3, strontium-90, plutonium-239, and americium-241 were obtained from Table 4.7, while maximum sediment concentrations for cesium-137, plutonium-239, and americium-241 were obtained from Table 4.10. Summing the ratios of their respective BCGs for each radionuclide resulted in a dose estimate of 0.0028 rad/yr to aquatic biota. This is well below the 365 rad/yr limit in DOE Order 5400.5 and demonstrates compliance with the limit.

Sawmill Creek flows into the Des Plaines River. The flow rate of Sawmill Creek (see Section 1.6) is about 0.28 m^3/s (10 ft^3/s); the flow rate of the Des Plaines River in the vicinity of ANL-E is about 25 m^3/s (900 ft^3/s). Applying this ratio to the concentration of radionuclides in Sawmill Creek listed in Table 4.28, the dose to a hypothetical individual ingesting water from the Des Plaines River at Lemont would be about 0.0002 mrem/yr. Significant additional dilution occurs further downstream. Very few people, either directly or indirectly, use the Des Plaines River as a

TABLE 4.24

Radiological Airborne Releases from Building 411/415 (APS), 2002

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	1,500	4.8×10^{-4}	2,000	2.7×10^{-4}
NNE	1,600	5.2×10^{-4}	2,100	3.0×10^{-4}
NE	2,200	2.8×10^{-4}	3,100	1.3×10^{-4}
ENE	2,500	2.0×10^{-4}	3,300	1.1×10^{-4}
E	1,600	4.5×10^{-4}	3,400	9.0×10^{-5}
ESE	1,500	4.2×10^{-4}	3,500	6.7×10^{-5}
SE	400	3.8×10^{-3}	3,000	5.8×10^{-5}
SSE	400	5.9×10^{-3}	3,000	9.6×10^{-5}
S	350	4.3×10^{-3}	2,500	1.0×10^{-4}
SSW	400	6.2×10^{-3}	2,800	1.2×10^{-4}
SW	550	3.8×10^{-3}	3,000	1.1×10^{-4}
WSW	800	9.2×10^{-4}	1,400	3.0×10^{-4}
W	800	1.2×10^{-3}	1,500	3.4×10^{-4}
WNW	500	1.7×10^{-3}	1,400	2.2×10^{-4}
NW	350	3.5×10^{-3}	1,600	1.9×10^{-4}
NNW	1,500	3.3×10^{-4}	2,000	1.8×10^{-4}

[a] Source terms: carbon-11 = 0.15 Ci (estimated)
nitrogen-13 = 10.90 Ci (estimated)
oxygen-15 = 1.19 Ci (estimated).

source of drinking water. If 100 people used Des Plaines River water at the hypothetical concentration at Lemont, the estimated population dose would be about 10^{-5} person-rem.

4.7.3. External Direct Radiation Pathway

The TLD measurements given in Section 4.5 were used to calculate the radiation dose from external sources. Above-background doses attributable to ANL-E operations were found at the southern boundary near the Waste Storage Facility (Location 7I).

At Location 7I, the fence-line dose from ANL-E was 111 ± 11 mrem/yr. Approximately 300 m (960 ft) south of the fence line (grid 6I), the measured dose was 103 ± 7 rem/yr, slightly

TABLE 4.25

Maximum Perimeter and Individual Doses
from Building 411/415 (APS) Air Emissions, 2002
(dose in mrem/yr)

Pathway	Perimeter (400 m SSW)	Individual (1,500 m W)
Ingestion	-[a]	-
Inhalation	1.8×10^{-4}	9.9×10^{-6}
Air immersion	6.0×10^{-3}	3.2×10^{-4}
Ground surface	1.0×10^{-4}	6.9×10^{-6}
Total	6.2×10^{-3}	3.4×10^{-4}
Radionuclide		
Carbon-11	8.7×10^{-5}	5.7×10^{-6}
Nitrogen-13	5.8×10^{-3}	3.2×10^{-4}
Oxygen-15	4.0×10^{-4}	9.0×10^{-6}
Total	6.2×10^{-3}	3.4×10^{-4}

[a] A hyphen indicates no exposure by this pathway.

higher than the off-site average (93 ± 4 mrem/yr). No individuals live in this area. The closest residents are about 1.6 km (1 mi) south of the fence line. At this distance, the calculated dose rate from the Waste Storage Facility would be 0.001 mrem/yr, if the energy of the radiation were that of a 0.66-MeV cesium-137 gamma ray, and approximately 0.003 mrem/yr, if the energy were that of a 1.33-MeV cobalt-60 gamma ray.

At the fence line, where higher doses were measured, the land is wooded and unoccupied. All of these dose calculations are based on full-time, outdoor exposure. Actual exposures to individuals would be substantially less because some of the individuals are indoors (which provides shielding) or away from their dwellings for part of the time. In addition to the permanent resident in the area, occasionally visitors may conduct activities around ANL-E that could result in exposure to radiation from this site. Examples of these activities could be cross-country skiing, horseback riding, or running in the fire lane next to the perimeter fence. If the individual spent 10 minutes per week adjacent to the 317 Area, the dose would be 0.002 mrem/yr at the 317 Area fence (Location 7I) from ANL-E operations.

4.7.4. Dose Summary

The total effective dose equivalent received by off-site residents during 2002 was a combination of the individual doses received through the separate pathways. Radionuclides that contributed through the air pathway are hydrogen-3, carbon-11, nitrogen-13, oxygen-15, argon-41, krypton-85, radon-220 (plus daughters), and actinides. The highest dose was approximately 0.039 mrem/yr to individuals living east of the site if they were outdoors at that location during the entire year. The total annual population dose to the entire area within an 80-km (50-mi) radius was 2.80 person-rem. The dose pathways are presented in Table 4.29 and are compared with the applicable standards.

To receive the maximum public dose, a hypothetical individual would need to live at the point of maximum air and direct radiation exposure and use only water from Sawmill Creek below the ANL-E wastewater discharge. This is a very conservative and unlikely situation. To put the maximum individual dose of 0.065 mrem/yr attributable to ANL-E operations into perspective, comparisons can be made with annual average doses (360 mrem) from natural or accepted sources of radiation received by an average American who could be living anywhere in the United States. These values are listed in Table 4.30. These site-related doses are in addition to the background doses. The magnitude of the doses received from ANL-E operations is insignificant compared with these sources. Therefore, the monitoring program results establish that the radioactive emissions from ANL-E are very low and do not endanger the health or safety of those living in the vicinity of the site.

TABLE 4.26

Population Dose within 80 km, 2002

Radionuclide	Person-rem
Hydrogen-3	0.18
Carbon-11	1.95
Nitrogen-13	<0.01
Oxygen-15	<0.01
Argon-41	0.57
Krypton-85	<0.01
Antimony-125	<0.01
Iodine-125	<0.01
Iodine-129	<0.01
Cesium-134	<0.01
Cesium-137	<0.01
Cerium-144	<0.01
Europium-154	<0.01
Europium-155	<0.01
Radon-220	<0.01
Uranium-234	<0.01
Uranium-238	<0.01
Plutonium-238	<0.01
Plutonium-239	0.07
Plutonium-240	0.01
Plutonium-241	<0.01
Plutonium-242	<0.01
Americium-241	<0.01
Curium-242	<0.01
Curium-244	<0.01
Total	2.8
Natural	2.7×10^6

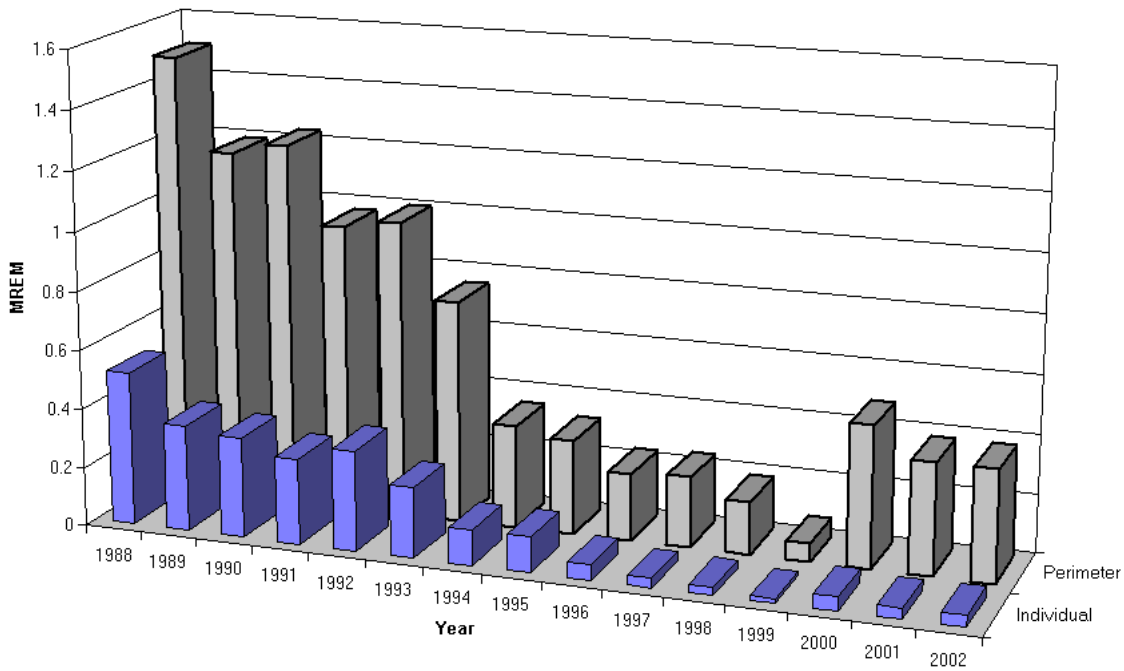


Figure 4.6 Individual and Perimeter Doses from Airborne Radioactive Emissions

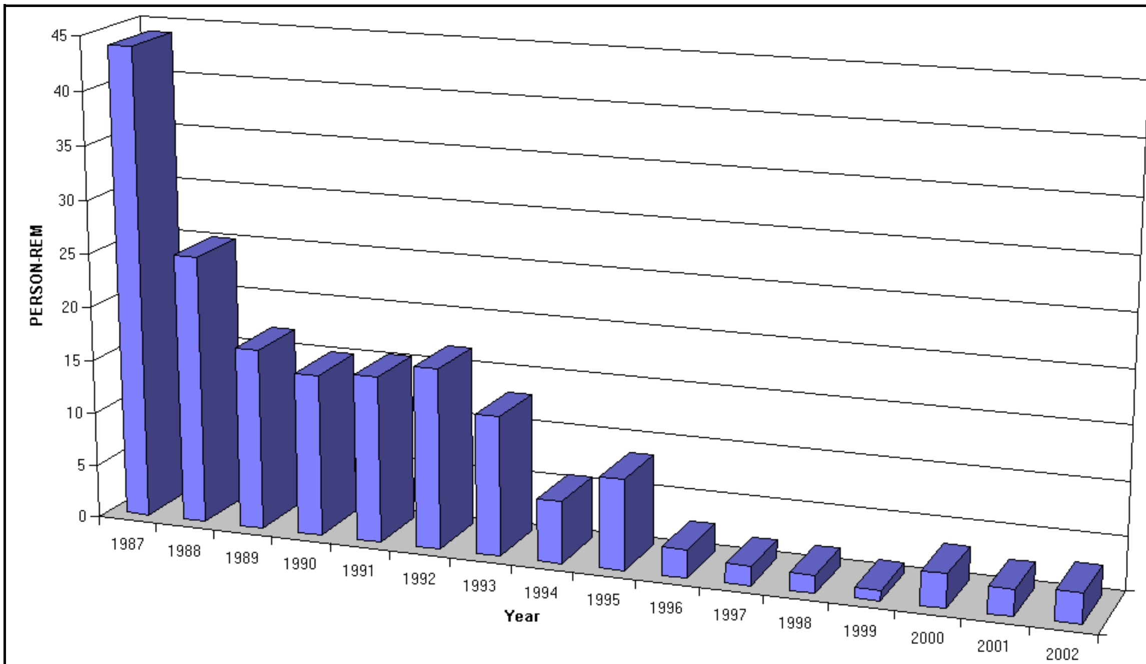


Figure 4.7 Population Dose from Airborne Radioactive Emissions

TABLE 4.27

50-Year Committed Effective Dose
Equivalent (CEDE) Conversion Factors
(rem/µCi)

Nuclide	Ingestion	Inhalation
Hydrogen-3	6.3×10^{-5}	9.6×10^{-5}
Beryllium-7	-[a]	2.7×10^{-4}
Carbon-11	-	8.0×10^{-6}
Strontium-90	0.13	1.32
Cesium-137	0.05	0.032
Lead-210	-	13.2
Radium-226	1.1	-
Thorium-228	-	310
Thorium-230	-	260
Thorium-232	-	1100
Uranium-234	0.26	130
Uranium-235	0.25	120
Uranium-238	0.23	120
Neptunium-237	3.9	-
Plutonium-238	3.8	-
Plutonium-239	4.3	330
Americium-241	4.5	-
Curium-242	0.11	-
Curium-244	2.3	-
Californium-249	4.6	-
Californium-252	0.94	-

[a] A hyphen indicates value not required.

TABLE 4.28

Radionuclide Concentrations and Dose Estimates
for Sawmill Creek Water, 2002

Radionuclide	Total Released (Ci)	Net Avg. Concentration (pCi/L)	Dose (mrem)
Hydrogen-3	0.10	45	0.0021
Strontium-90	0.0005	0.15	0.0142
Plutonium-239	<0.0001	<0.0001	<0.0003
Americium-241	<0.0001	<0.0001	<0.0003
Total	0.10		0.016

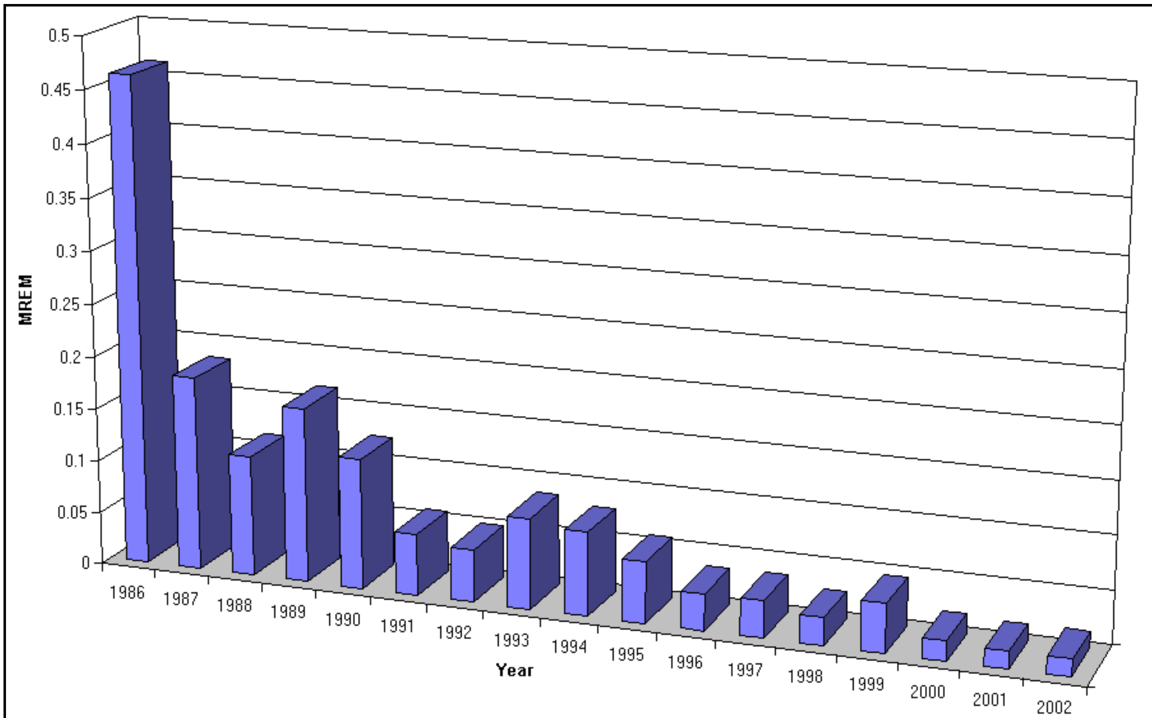


Figure 4.8 Comparison of Dose Estimate from Ingestion of Sawmill Creek Water

TABLE 4.29

Summary of the Estimated Dose to a Hypothetical Individual, 2002 (mrem/yr)

Pathway	ANL-E Estimate	Applicable Standard
Air (NESHAPs)	0.039	10 (EPA)
Air total	0.039	None
Water	0.016	4 (EPA)[a]
Direct radiation	0.010	25 (NRC)
Maximum dose	0.065	100 (DOE)

[a] The 4-mrem/yr EPA value is not an applicable standard since it applies to community water systems.[21] It is used here for illustrative purposes.

TABLE 4.30

Annual Average Dose Equivalent in the U.S. Population[a]

Source	Dose (mrem)
Natural	
Radon	200
Internal (potassium-40 and radium-226)	39
Cosmic	28
Terrestrial	28
Medical	
Diagnostic X-rays	39
Nuclear medicine	14
Consumer Products	
Domestic water supplies, building materials, etc.	10
Occupational (medical radiology, industrial radiography, research, etc.)	1
Nuclear fuel cycle	<1
Fallout	<1
Other miscellaneous sources	<1
Total	360

[a] National Council on Radiation Protection and Measurements Report No. 93.[18]

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

The nonradiological monitoring program primarily involves the collection and analysis of surface water and groundwater samples from numerous locations throughout the site. Chapter 3 provides a detailed discussion of the environmental monitoring program. The amount of nonradiological pollutants released to the air from ANL-E is extremely small (see Table 2.4), except for the conventional air pollutants emitted from the boiler house while burning coal. This unit is equipped with dedicated monitoring equipment for sulfur dioxide and opacity while burning coal. No exceedances were noted during 2002 over a period of 1,832 hours of coal-burning operation of Boiler No. 5, the coal-burning boiler (see Section 2.1.2). No other air monitoring for nonradiological pollutants is performed, except for landfill gas monitoring (see Section 2.1.2).

Surface water samples for nonradiological chemical analyses are collected from NPDES-permitted outfalls and Sawmill Creek.[22] Analyses conducted on the samples from the NPDES outfalls vary, depending on the permit-mandated monitoring requirements for each outfall. The results of the analyses are compared with the permit limits for each outfall to determine whether they comply with the permit. In addition to being published in this report, the NPDES monitoring results are transmitted monthly to the IEPA in an official DMR.

In addition to the permit-required monitoring, other analyses are conducted on samples collected from the combined wastewater outfall (NPDES Outfall 001) to provide a more complete evaluation of the impact of the wastewater on the environment. Water samples from Sawmill Creek are also collected and analyzed for a number of inorganic constituents. The results of these additional analyses of the main outfall and receiving streams are then compared with IEPA General Effluent Standards and Stream Quality Standards listed in IAC, Title 35, Subtitle C, Chapter I.[23]

5.1. National Pollutant Discharge Elimination System Monitoring Results

5.1.1. Influent Monitoring

Since 1989, analyses of the laboratory wastewater influent have shown the presence of a variety of VOCs with variable concentrations. Although disposing of waste chemicals to the drain is not authorized, residual VOCs are released to the laboratory sewer from laboratory-related activities such as rinsing glassware. Also, VOCs are known to be discharged into the laboratory sewer from the 317/319 Lift Station, which pumps contaminated groundwater generated by ANL-E's RCRA corrective actions. Table 5.1 gives the results of the analysis of laboratory wastewater influent.

TABLE 5.1

Laboratory Influent Wastewater, 2002
(concentrations in μg/L)

Month	Acetone	Chloroform	Bromodi-chloroethane	Dibromo-chloromethane	Bromoform
January	25	8	5	2	<1
February	<1	4	3	1	<1
March	89	6	2	<1	<1
April	<1	6	2	1	<1
May	19	5	3	3	2
June	5	4	3	2	<1
July	13	5	3	1	<1
August	2	4	3	2	<1
September	3	5	3	1	<1
October	4	2	2	<1	<1
November	9	3	3	2	<1
December	6	3	3	1	1
Average	18	5	3	2	<2

The 2002 results for laboratory influent wastewater are quite similar to those from 1997 to 2001. Table 5.1 gives the 2002 results for the most common compounds detected. Bromoform, bromodichloromethane, chloroform, and dibromochloromethane are halomethanes that are produced as the result of contact of the chlorinated water supply with organic chemicals. Research activity may account for the presence of other volatiles.

As in 1999, 2000, and 2001, acetone was detected in 11 samples and levels ranged up to 89 μg/L. The yearly average was lower than previous years (Figure 5.1). Infrequent trace levels of other chemicals, that is, 2-butanone, acetaldehyde, ethanol, and 2-methylpropanol, were also noted but not shown in Table 5.1.

Figures 5.1 and 5.2 present comparisons of the 1992 through 2002 laboratory influent wastewater results for the two more common VOCs, acetone and chloroform. The presence of acetone is likely due to laboratory activities such as rinsing glassware. Disposing of hazardous chemicals down laboratory drains is not authorized at ANL-E. ANL-E conducts a waste generator education program as part of its site safety awareness training program, in which proper handling and disposal of chemicals are explained. However, normal use of certain chemicals, such as acetone,

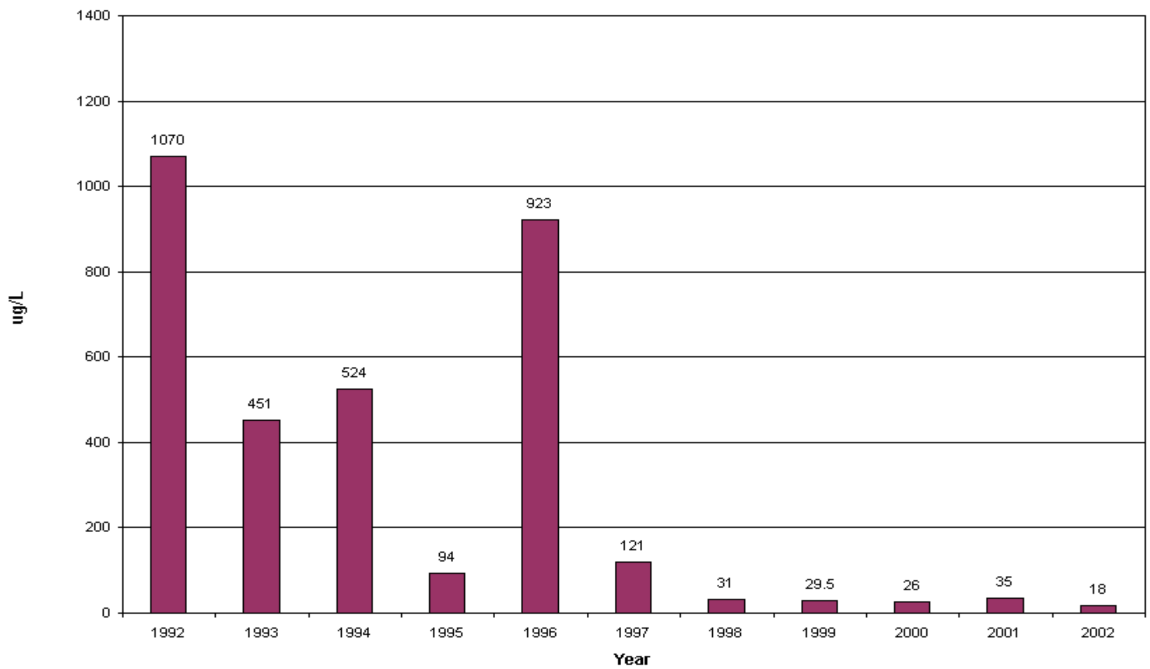


Figure 5.1 Average Acetone Levels in Laboratory Influent Wastewater, 1992 to 2002

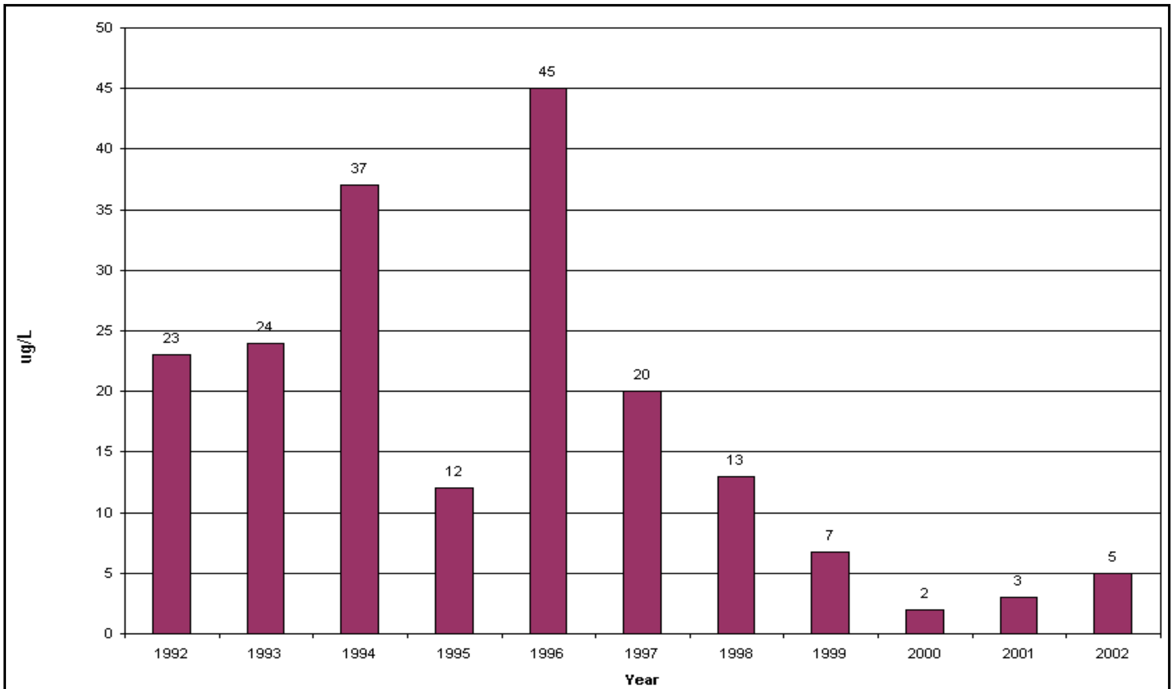


Figure 5.2 Average Chloroform Levels in Laboratory Influent Wastewater, 1992 to 2002

often results in the discharge of small amounts into the sewer. The decrease in influent concentrations of acetone and chloroform over the past several years shows the effectiveness of educational efforts related to waste disposal and pollution prevention.

5.1.2. Effluent Monitoring

Section 2.2 of Chapter 2 describes the outfalls on the ANL-E site. Table 2.5 contains a complete list of all the outfalls. In general, the outfalls fall into two groups: those that have some type of process wastewater discharge and those that contain only storm water runoff following a rain event. The sampling requirements of the process wastewater outfalls depend on the nature of the activity generating the wastewater. This section discusses those requirements and the results of the monitoring. The storm water outfalls are listed in the permit, but they do not require routine monitoring of the discharges.

Effluent samples are collected from ANL-E point-source discharges (outfalls) as specified by the NPDES Permit. The permit specifies the frequency of sample collection and the specific parameters to be monitored for each individual outfall. Sample collection, preservation, holding times, and analytical methods are specified by the EPA as codified in 40 CFR Part 136, Tables 1B and 2.[24]

The NPDES outfall locations are shown in Figure 5.3. Outfalls 001A and 001B, the two internal monitoring points representing the effluent from the sanitary system and laboratory system, respectively, are both located at the WTP. Their flows combine to form Outfall 001, which also is located at the treatment facility. The combined stream flows through an outfall pipe that discharges into Sawmill Creek approximately 1,100 m (3,500 ft) south of the treatment plant.

In addition to the main wastewater outfalls, a small amount of process wastewater, primarily cooling tower blowdown and cooling water, is discharged directly to a number of small streams and ditches throughout the site. This wastewater does not contain significant amounts of contaminants and does not require treatment before discharge. These discharge points are included in the site NPDES Permit as separate regulated outfalls.

5.1.2.1. Sample Collection

All samples are collected in specially cleaned and labeled bottles with appropriate preservatives added. Custody seals and chain of custody sheets also are used. All samples are analyzed within the required holding time. Samples are collected at locations 001A, 001B, and 001 on a weekly basis, consistent with permit requirements. Similarly, samples are collected at the other locations in accordance with the NPDES Permit.

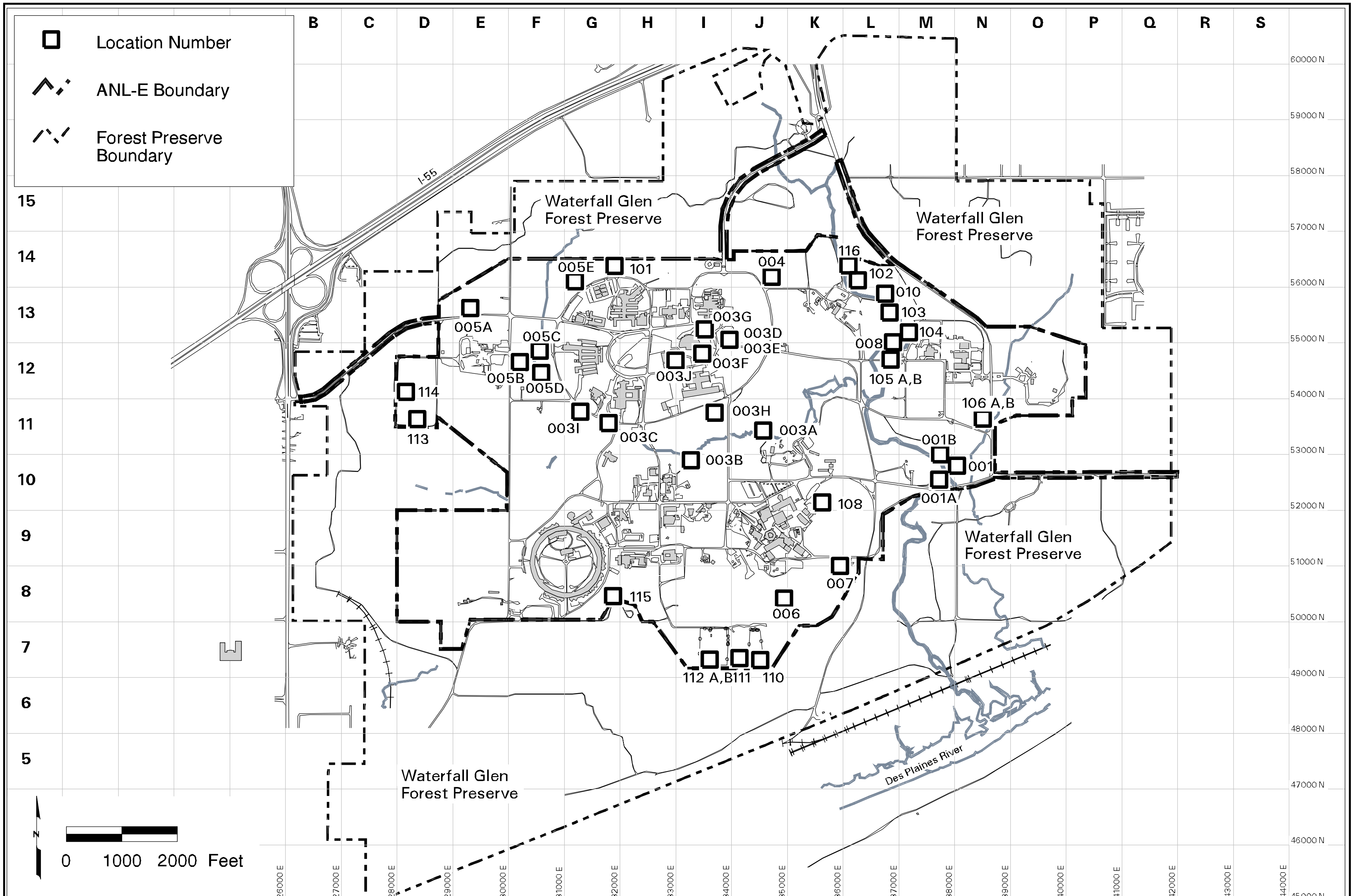


Figure 5.3 NPDES Outfall Locations

5.1.2.2. Sample Analyses - NPDES

NPDES sample analyses were performed in accordance with standard operating procedures (SOPs) that were issued as controlled documents. These SOPs cite protocols that can be found in 40 CFR Part 136, "Test Procedures for the Analysis of Pollutants Under the Clean Water Act."[24] Six metal analyses were performed by using inductively coupled plasma atomic emission spectroscopy. Mercury was determined by cold vapor atomic absorption spectroscopy. Hexavalent chromium determination and chemical oxygen demand (COD) were performed by using a colorimetric technique. Five-day biochemical oxygen demand (BOD_5) was determined by using a dissolved oxygen probe. TSS, TDS, and oils and grease were determined gravimetrically. Sulfate determination was performed by using a turbidimetric technique; chloride was determined by titrimetry. Ammonia nitrogen was determined by distillation, followed by an ion-selective electrode measurement. VOC concentrations were determined by using a purge and trap sample pretreatment, followed by gas chromatography-mass spectroscopy detection. The PCB Aroclor-1260® concentrations were determined by solvent extraction, followed by gas chromatography-electron capture detection. Beta radioactivity was performed by using a gas flow proportional counting technique. Hydrogen-3 concentrations were determined by distillation, followed by a beta liquid scintillation counting technique.

NPDES Outfall 001B is sampled and analyzed semiannually for priority pollutant compounds. VOCs were determined by using a purge and trap sample pretreatment, followed by gas chromatography-mass spectroscopy detection. Semivolatile organic compounds (SVOCs) were determined by solvent extraction, followed by gas chromatography-mass spectroscopy detection. PCBs and pesticides were determined by solvent extraction, followed by gas chromatography-electron capture detection. Thirteen metals were determined by graphite furnace atomic absorption and inductively coupled plasma atomic emission spectroscopy. Cyanide and phenol were determined by distillation, followed by a spectrophotometric measurement.

NPDES Outfall 001 is sampled and analyzed annually during June for acute aquatic toxicity parameters. NPDES Outfalls 003H, 003I, 003J, 004, 006, and 115 are tested in July and August for acute aquatic toxicity. An off-site contract laboratory performs both the sample collection and analyses. The testing is performed by diluting a series of ANL-E effluent samples with Sawmill Creek receiving water, into which species of fish and invertebrates are introduced. Survival is measured over two to four days, and statistically significant mortality is reported as a function of effluent concentration.

5.1.2.3. Results

During 2002, approximately 99% of all NPDES analyses were in compliance with their applicable permit limits, as compared with 1991 through 2001, when rates ranged from 96 to 99%.

Specific limit exceedances are discussed later in this section, as well as in Chapter 2. A discussion of the analytical results for each outfall follows.

5.1.2.4. Wastewater Treatment Facility Outfalls

Outfall 001A. This outfall consists of treated sanitary wastewater. Until fall of 2001, it also consisted of various wastewater streams from the boiler house area, including coal pile storm water runoff. These wastewater streams are now directed to the DuPage County system. The effectiveness of the sanitary wastewater treatment systems is evaluated by weekly monitoring for BOD_5, pH, and TSS. The limits for BOD_5 are a monthly average of 10 mg/L and a maximum value of 20 mg/L. The permit limits for TSS are a maximum concentration of 24 mg/L and a monthly average of 12 mg/L. The pH must range between values of 6 and 9. All samples collected and analyzed for these parameters during 2002 were within the permit limits.

The permit requires weekly monitoring for total chromium, copper, iron, lead, manganese, zinc, and oil and grease. Table 5.2 gives the effluent limits for these parameters and monitoring results. Two limits are listed; one is a maximum limit for any single sample, and the other is for the average of all samples collected during the month. The constituents in Table 5.2 are present in the coal pile runoff. As of fall 2001, coal pile runoff is discharged to the laboratory sewage system. No limits were exceeded during 2002.

TABLE 5.2

Outfall 001A Effluent Limits and Monitoring Results, 2002
(concentrations in mg/L)

Constituent	Minimum	Average	Average Limit	Maximum	Maximum Limit
Chromium	-[a]	<0.015	1.0	<0.015	2.0
Copper	<0.015	0.021	0.50	0.031	1.0
Iron	0.057	0.087	2.0	0.167	4.0
Lead	-	<0.10	0.20	<0.10	0.40
Manganese	<0.011	<0.019	1.0	0.040	2.0
Zinc	0.053	0.084	1.0	0.118	2.0
Oil and grease	-	<5.0	15.0	<5.0	30.0

[a] A hyphen indicates no minimum value.

Outfall 001B. This outfall consists of processed wastewater from the laboratory wastewater system and the coal pile runoff. The permit requires that weekly samples be collected and analyzed for BOD_5, TSS, mercury, pH, and COD.

The limits established for BOD_5 are a daily maximum of 20 mg/L and a 30-day average of 10 mg/L. The permit also contains BOD_5 mass loading limits of 52 kg/day (114 lb/day) as a daily maximum and 26 kg/day (57 lb/day) as a 30-day average. The mass loading represents the weight of material discharged per day and is a function of concentration and flow. The daily maximum concentration limit for TSS is 24 mg/L; the 30-day average is 12 mg/L. The TSS mass loading limits are 62 maximum and 31 average kg/day (136 and 68 lb/day), respectively. No exceedances of the TSS or BOD_5 mass loading and concentration limits were noted in 2002.

The daily maximum concentration limit for mercury is 6 μg/L; the 30-day average is 3 μg/L. The corresponding loading values are 0.02 kg/day (0.034 lb/day) and 0.01 kg/day (0.017 lb/day). No exceedances of the mercury loading and concentration limits were noted during 2002. The values obtained in 2002 ranged from less than 0.0001 to 0.0001 mg/L.

No concentration limits have been established for COD. The once-per-week grab samples give a rough indication of the organic and inorganic oxygen-consuming contents of this effluent stream. The values obtained in 2002 ranged from less than 10 to 22 mg/L.

A special condition at Location 001B requires monitoring for the 124 priority pollutants listed in the permit during the months of June and December. The June sampling is to be conducted at the same time that aquatic toxicity testing of Outfall 001 is conducted. Samples were collected on June 17, 2002, and December 3, 2002, and analyzed within the required holding times.

Analysis of these samples indicated that very small amounts of a few chemicals were present. The results for SVOCs, PCBs, and pesticides were all less than the detection limits. The results for metals were similar to concentrations historically found in ANL-E–treated drinking water. Very low levels of arsenic (0.0033 mg/L), selenium (0.004 mg/L), silver (0.0046 mg/L), and thallium (0.0021 mg/L) were detected in the June sample. Copper was detected at a very low level (0.017 mg/L) in the December sample. Zinc was detected at low levels in the June (0.036 mg/L) and December (0.165 mg/L) samples. The samples contained some VOCs at very low levels. The majority of compounds detected were halomethanes, which are found in chlorinated drinking water. Table 5.3 lists the concentrations of volatile organics identified in these samples. Currently, no permit limits or effluent standards are available for these compounds for comparison with these results.

Outfall 001. After the treatment processes, the effluents from both the laboratory and sanitary WTP are combined to form one point-source discharge. The combined effluent flows through a 1,100-m (3,500-ft) outfall pipe where it is eventually discharged into Sawmill Creek.

TABLE 5.3

Outfall 001B Effluent Priority Pollutant Monitoring Results, 2002
(concentrations in μg/L)

Compound	Concentration in June Sample	Concentration in December Sample
Bromodichloromethane	2	2
Bromoform	1	<1
Chloroform	3	3
Dibromochloromethane	1	1

Samples of the combined effluent are collected weekly or monthly as grab samples or 24-hour composite samples as specified in the NPDES Permit. The samples are analyzed for a variety of metals, ammonia nitrogen, chlorides, sulfates, TDS, pH, and beta radioactivity. The permit requires analysis of the combined effluent once a week for TDS, chloride, and sulfate. Table 5.4 gives the results, limits, and number of exceedances.

Two exceedances of the TDS limit were noted during 2002. Elevated TDS levels occurred only during the 2002 heating season. They are believed to be related to the combination of reduced flows, boiler blowdown, and increases in TDS concentrations from road salt. For the past several years, chemical analysis for chloride has indicated a close relationship between TDS levels and chloride levels. Figure 5.4 shows the results of TDS and chloride analyses for 1995 through 2002. Elevated TDS levels prior to 1997 are attributed to high TDS levels (800 ppm) in ANL-E's domestic source water (i.e., groundwater, at that time).

In 1997, Lake Michigan water, which is characterized by low TDS levels (200 to 400 ppm), became ANL-E's domestic source water. Figure 5.5 shows that average TDS levels at Outfall 001 have substantially decreased since the introduction of Lake Michigan water.

TABLE 5.4

Outfall 001 Monitoring Results and Effluent Limits, 2002
(concentrations in mg/L)

Constituent	Minimum	Average	Maximum	Limit	Exceedances
Chloride	92	184	456	500	0
Copper	<0.010	<0.017	0.037	0.051	0
TDS	510	698	1,117	1,000	2
Ammonia nitrogen	<0.04	0.4	1.9	10.0 (November–March) 3.0 (April–October)	0

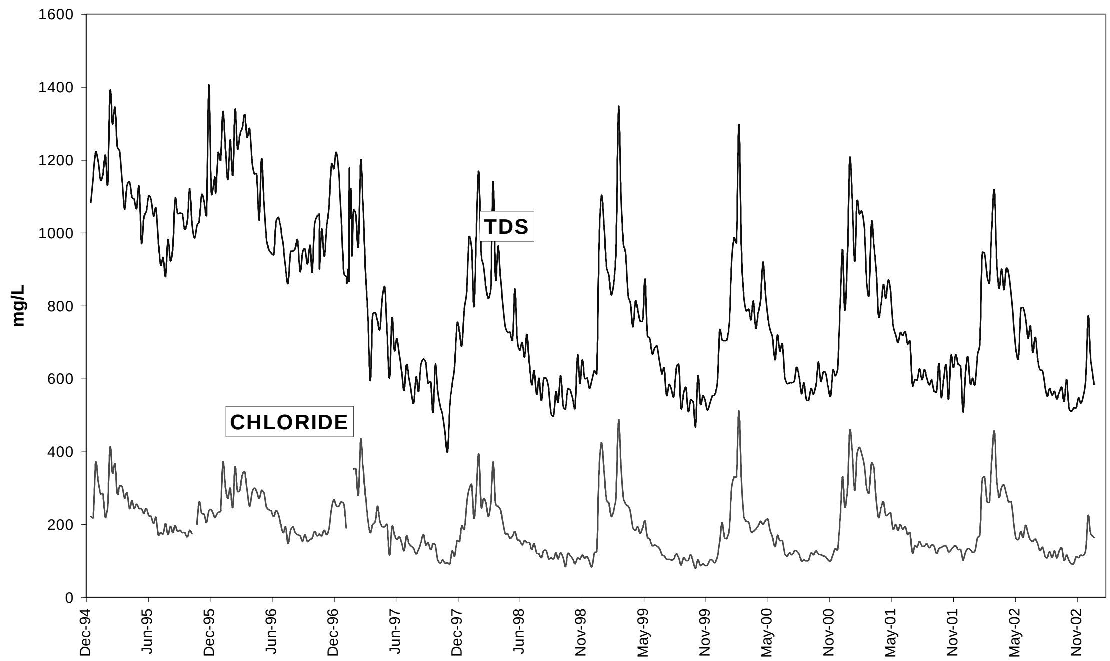


Figure 5.4 Total Dissolved Solids and Chloride in Outfall 001 Water, 1995 to 2002

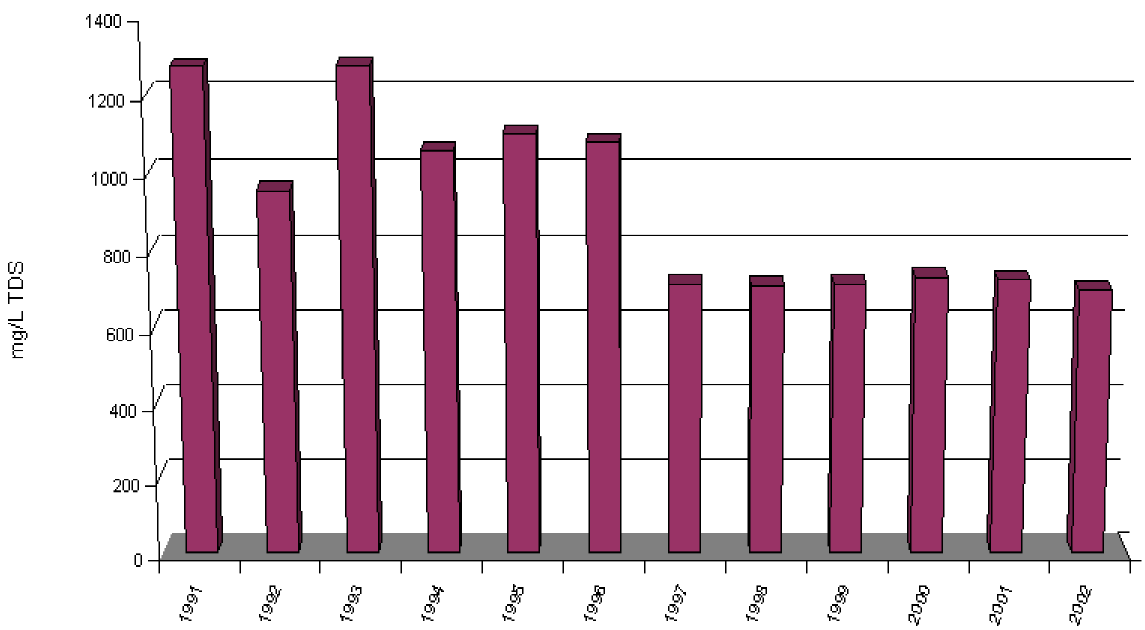


Figure 5.5 Average TDS Concentrations at NPDES Outfall 001, 1991 to 2002

The permit requires that a biological toxicity screening test be performed on wastewater from Outfall 001 in June of each year. The toxicity testing is run on two trophic levels of aquatic species for acute toxicity. The 2002 testing was conducted on samples collected June 17 through 21; the water flea (*Ceriodaphnia dubia*) and fathead minnow (*Pimephales promelas*) were used.

No toxicity was observed to the fathead minnow or to the water flea. The concentration of wastewater that produces 50% mortality in the test population (i.e., the LC_{50}) for both species is greater than 100%; that is, the pure, undiluted effluent is not toxic to these species. Tables 5.5 and 5.6 summarize the results of the toxicity tests from 2000 to 2002.

The permit also requires that weekly pH, ammonia nitrogen, dissolved iron, manganese, and zinc measurements be made. Monthly monitoring for lead, hexavalent and trivalent chromium, and beta radioactivity is required. No exceedances of these parameters were noted in 2002. In addition to the outfalls at the WTP, a number of other outfalls are monitored. The sampling requirements and effluent limits for these outfalls are described in Table 5.5.

Special Condition No. 9 of the NPDES Permit requires acute toxicity testing of the effluent from Outfalls 003H, 003I, 003J, 004, 006, and 115. The testing is performed on the fathead minnow and the water flea. The testing is performed during the months of July and August. These outfalls were sampled during the periods of July 22 to 26 and August 19 to 23, 2002. The results are summarized in Tables 5.6 and 5.7. The results are discussed by month below.

July 2002 — Effluents from Outfalls 003H, 004, 006, and 115 exhibited no acute toxicity. Outfall 003J was acutely toxic toward both the fathead minnow and the water flea with LC_{50} values of less than 20 and 29%, respectively. The toxicant at Outfall 003J appeared to be residual chlorine, on the basis of measured concentrations of 2.2 mg/L. The toxicity levels at 003J were similar to those observed in July 2001. Outfall 003I was slightly acutely toxic toward the water flea with a LC_{50} value of greater than 100% but not fathead minnows. The toxicants at Outfall 003I were unidentified.

August 2002 — Effluents from Outfalls 003H, 004, 006, and 115 were not acutely toxic toward the water flea and fathead minnows. Effluents from Outfalls 003I and 003J were acutely toxic toward the water flea with median lethal concentration (LC_{50}) values of 88.5% and less than 20%, respectively. Effluents from Outfall 003J were also acutely toxic to the fathead minnow with an LC_{50} value of 45.1%. The presence of chlorine at high concentrations (measured at 1.51 mg/L) is the probable cause of the toxicity at Outfall 003J.

TABLE 5.5

Summary of Monitored NPDES Outfalls, 2002

Discharge Location	No. of Samples	Permit Constituent	Limit 30-Day Average	Limit Daily Maximum	No. Exceeding Limit
003A	0	Flow	None		0
		pH	6–9		0
		TSS	15	30	0
		TRC[a]	0.05		0
003B	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
003C	12	Flow	None		0
		pH	6–9		0
003D	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
003E	10	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
003F	9	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
		TDS	Monitor only		NA[b]
003G	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
003H	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
		TDS	Monitor only		NA

TABLE 5.5 (Cont.)

Discharge Location	No. of Samples	Permit Constituent	Limit 30-Day Average	Limit Daily Maximum	No. Exceeding Limit
003I	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
		TDS	Monitor only		NA
		Oil and grease	Monitor only		NA
003J	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
		TDS	Monitor only		NA
004	12	Flow	None		0
		pH	6–9		0
		TSS	15	30	0
005C	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
		Oil and grease	Monitor only		NA
005E	11	Flow	None		0
		pH	6–9		0
006	12	Flow	None		0
		pH	6–9		0
		TSS	15	30	0
		TDS	Monitor only		NA
		Temperature	<2.8°C rise		0
007	12	Flow	None		0
	12	pH	6–9		0
	12	Temperature	<2.8°C rise		0
	48	TRC	0.05		4
	12	Oil and grease	Monitor only		NA
008	12	Flow	None		0
		pH	6–9		0
		VOC	Monitor only		NA

TABLE 5.5 (Cont.)

Discharge Location	No. of Samples	Permit Constituent	Limit 30-Day Average	Limit Daily Maximum	No. Exceeding Limit
010	0	Flow	None		0
		pH	6–9		0
		TSS	15	30	0
		Total iron	2	4	0
		Dissolved iron		1.0	0
		Lead		0.1	0
		Zinc		1.0	0
		Manganese		1.0	0
		Hexavalent chromium	0.011	0.016	0
		Trivalent chromium	0.519	2.0	0
		Copper	0.031	0.051	0
		Oil and grease	15	30	0
108	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
111	2	Flow	None		0
		Hydrogen-3	Monitor only		NA
112A	2	Flow	None		0
		Hydrogen-3	Monitor only		NA
112B	2	Flow	None		0
		Hydrogen-3	Monitor only		NA
113	6	Flow	None		0
		Hydrogen-3	Monitor only		NA
		PCB 1260	Monitor only		NA
		Lead, copper, nickel, zinc	Monitor only		NA
114	5	Flow	None		0
		Hydrogen-3	Monitor only		NA
		PCB 1260	Monitor only		NA
		Lead, copper, nickel, zinc	Monitor only		NA

TABLE 5.5 (Cont.)

Discharge Location	No. of Samples	Permit Constituent	Limit: 30-Day Average	Limit: Daily Maximum	No. Exceeding Limit
115	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
		TDS	Monitor only		NA
116	12	Flow	None		0
		pH	6–9		0
		TRC	0.05		0

[a] TRC = total residual chlorine.

[b] NA = not applicable.

TABLE 5.6

Water Flea, 48-Hour Acute Toxicity Results - LC_{50}, 2000 to 2002

NPDES Outfall	2000 (%) June/July	2000 (%) August	2001 (%) June/July	2001 (%) August	2002 (%) June/July	2002 (%) August
001	>100	NA[a]	>100	NA	>100	NA
003H	>100	>100	>100	>100	>100	>100
003I	>100	>100	**71**	>100	>100	**88**[b]
003J	>100	**<20**	**<20**	>100	**<20**	**<20**
004	>100	>100	>100	>100	>100	>100
006	>100	**30**	**40**	**60**	>100	>100
115	**29**	**<20**	**64**	>100	>100	>100

[a] NA = not applicable.

[b] Bold percentage represents acute toxicity.

TABLE 5.7

Fathead Minnow, 96-Hour Acute Toxicity Results - LC_{50}, 2000 to 2002

NPDES Outfall	2000 (%) June/July	2000 (%) August	2001 (%) June/July	2001 (%) August	2002 (%) June/July	2002 (%) August
001	>100	NA[a]	>100	NA	>100	NA
003H	>100	>100	>100	>100	>100	>100
003I	>100	>100	>100	>100	>100	>100
003J	>100	**40**[b]	<20	>100	**30**	**45**
004	>100	>100	>100	>100	>100	>100
006	>100	>100	>100	>100	>100	>100
115	>100	>100	>100	>100	>100	>100

[a] NA = not applicable.

[b] Bold percentage represents acute toxicity.

5.2. Additional Effluent Monitoring

To characterize the wastewater from the ANL-E site more fully, composite samples of the combined effluent from the WTP were collected each week and analyzed for the constituents shown in Table 5.8. The results were then compared with IEPA General Effluent Limits found in 35 IAC, Subtitle C, Part 304.[25]

5.2.1. Sample Collection

Samples for analysis of inorganic constituents were collected daily from Outfall 001 located at the WTP by using a refrigerated time-proportional sampler. A portion of the sample was transferred to a clean bottle, a security seal was affixed, and chain of custody was maintained. Five daily samples were composited on an equal volume basis to produce a weekly sample that was then analyzed.

5.2.2. Results

Fifteen metals were determined by inductively coupled plasma emission spectroscopy and graphite furnace atomic absorption spectroscopy. Mercury was analyzed using cold vapor atomic absorption spectroscopy, and fluoride was determined by a specific ion electrode. Table 5.8 gives the results for 2002. The maximum result for mercury exceeded General Effluent Limits.[25] The

TABLE 5.8

Chemical Constituents in Effluents from the ANL-E
Wastewater Treatment Plant, 2002

		Concentration (mg/L)			
Constituent	No. of Samples	Average	Minimum	Maximum	Limit
Arsenic	52	< 0.0030	< 0.0030	0.0030	0.25
Barium	52	0.0189	0.0131	0.0248	2.0
Beryllium	52			< 0.0002[a]	-[b]
Cadmium	52	< 0.0002	< 0.0002	0.0002	0.15
Chromium	52	< 0.0240	< 0.0240	0.0240	1.0
Cobalt	52			< 0.0160	-
Copper	52	0.0172	< 0.0150	0.0268	0.5
Fluoride	52	0.9176	0.5540	1.2050	15.0
Iron	52	0.0401	< 0.0200	0.1276	2.0
Lead	52	< 0.0020	< 0.0020	0.0020	0.2
Manganese	52	0.0135	< 0.0100	0.0516	1.0
Mercury	52	0.0001	< 0.0001	0.0010	0.0005
Nickel	52			< 0.0200	1.0
Silver	52	0.0010	< 0.0010	0.0013	0.1
Thallium	52	< 0.0020	< 0.0020	0.0020	-
Vanadium	52	< 0.0320	< 0.0320	0.0320	-
Zinc	52	0.0713	0.0362	0.1364	1.0
pH (units)	51	NA[c]	6.90	7.98	6.0–9.0

[a] If all values are less than the detection limit for a constituent, only the detection limit value is given.

[b] A hyphen indicates no effluent limit for this constituent.

[c] NA = not applicable.

source of this exceedance is unknown. The annual average result for mercury was well below the limit.

5.3. Sawmill Creek

Sawmill Creek is a small natural stream that is fed primarily by storm water runoff. During periods of low precipitation, the creek above ANL-E has a very low flow. At these times, a major portion of the water in Sawmill Creek south of the site consists of ANL-E wastewater and discharges to assorted storm drains. To determine the impact ANL-E wastewaters have on Sawmill Creek, samples of the creek downstream of all ANL-E discharge points were collected and analyzed. The results were then compared with IEPA General Use Water Quality Standards found in 35 IAC, Subtitle C, Part 302.[26]

5.3.1. Sample Collection

A time-proportional sampler was used to collect a daily sample at a point well downstream of the combined wastewater discharge point where thorough mixing of the ANL-E effluent and Sawmill Creek water is assured. Samples were collected in precleaned, labeled bottles and security seals were used. After pH measurement, the daily samples were acidified and then combined into equal volume weekly composites and analyzed for the same set of inorganic constituents as those in Table 5.8.

Fifteen metals were determined by inductively coupled plasma emission spectroscopy and graphite furnace atomic absorption spectroscopy. Mercury was analyzed with cold vapor atomic absorption spectroscopy. Fluoride was determined by a specific ion electrode.

5.3.2. Results

The results obtained for 2002 are shown in Table 5.9. None of the annual average results exceeded General Use Water Quality Standards.[26]

TABLE 5.9

Chemical Constituents in Sawmill Creek, Location 7M,[a] 2002

Constituent	No. of Samples	Concentrations (mg/L) Average	Minimum	Maximum	Limit
Arsenic	51	< 0.0030	< 0.0030	0.0030	0.36[b]
Barium	51	0.0318	0.0176	0.0617	5.0
Beryllium	51			< 0.0002[c]	-[d]
Cadmium	51	< 0.0002	< 0.0002	0.0002	0.03[b]
Chromium	51	< 0.0240	< 0.0240	0.0240	3.6[b]
Cobalt	51			< 0.0160	-
Copper	51	0.0150	0.0150	0.0172	0.041[b]
Fluoride	51	0.6361	0.3020	1.1030	1.4
Iron	51	0.0510	< 0.0200	0.2042	1.0
Lead	51	0.0020	0.0020	0.0032	0.3[b]
Manganese	51	0.0140	< 0.0100	0.0421	1.0
Mercury	51	0.0001	< 0.0001	0.0002	0.0026[b]
Nickel	51			< 0.0200	1.0
Silver	51	0.0010	< 0.0010	0.0012	0.005
Thallium	51	< 0.0020	< 0.0020	0.0020	-
Vanadium	51	< 0.0320	< 0.0320	0.0320	-
Zinc	51	0.0304	< 0.0080	0.0816	1.0
pH (units)	51	NA[e]	6.10	7.81	6.5–9.0

[a] Location 7M is 15 m (50 ft) downstream from the ANL-E wastewater outfall.

[b] The acute standard for the chemical constituent is listed.

[c] If all values are less than the detection limit for a constituent, only the detection limit is given.

[d] A hyphen indicates no effluent limit for this constituent.

[e] NA = not applicable.

6. GROUNDWATER PROTECTION

The groundwater below the ANL-E site is monitored through the collection and analysis of samples obtained from the former on-site water supply wells, from a series of groundwater monitoring wells located near several sites that have the potential for affecting groundwater, and other monitoring wells on and off the ANL-E site. Regulations establishing comprehensive WQSs for the protection of groundwater have been enacted — IEPA Groundwater Quality Standards, 35 IAC, Subtitle F, Part 620.[27] In addition, demonstration of compliance with the groundwater protection requirements in DOE Order 5400.1,[1] as related to sitewide characterization studies and monitoring well requirements, is presented in this chapter. The permit for the 800 Area Landfill requires a groundwater monitoring program; the program was initiated in July 1992. Information generated by this program is also included in this report.

6.1. Former Potable Water System

Domestic water for ANL-E was supplied by four wells (see Section 1.7 and Table 6.1) until early 1997, when Lake Michigan water was obtained. The well locations are shown in Figure 1.1. Lake Michigan water was obtained to provide better quality drinking water. The dolomite water from the on-site wells had deteriorated in quality to where the TDS content of the supply water was approaching 800 mg/L, which made it difficult to consistently meet the 1,000-mg/L TDS discharge limit at NPDES Outfall 001. Lake Michigan water has a TDS range of approximately 200 to 400 mg/L. In addition, Lake Michigan water is lower in bicarbonate, which makes it less corrosive on the piping system. The former potable wells, however, are maintained as a backup in the case of loss of Lake Michigan water.

6.1.1. Informational Monitoring

Samples were collected quarterly at the wellhead, except for Well 2, which is no longer operational, and were analyzed to determine the presence of several types of radioactive constituents and VOCs in ANL-E groundwater. Samples from each well were tested for total alpha, total beta, hydrogen-3, and strontium-90. Samples also were analyzed annually for radium-226, radium-228, and isotopic uranium. Alpha and beta radioactivity were determined by a gas-flow–proportional counting technique. Hydrogen-3 was determined by distillation followed by a beta liquid scintillation counting technique. Strontium-90 was determined by ion-exchange separations followed by proportional counting. Radium and uranium were analyzed by ion-exchange separations followed by gamma and alpha spectrometry, respectively. The results are presented in Table 6.2.

VOC samples were collected quarterly, analyzed for SDWA volatile compounds, and quantified by EPA Method 524.2,[28] which includes purge and trap pretreatment, followed by gas chromatography-mass spectroscopy detection. The reporting limit is the Practical Quantification Limit (PQL), which is defined as 10 times the method detection limit.

TABLE 6.1

ANL-E Former Water Supply Wells

Well No.	Location	Well Elevation (m AMSL)[a]	Bedrock Elevation (m AMSL)	Well Depth (m bgs)[b]	Inner Diameter (m)	Year Drilled
1	Building 31	204.5	184.4	86.6	0.30	1948
2[c]	Building 32	202.4	183.2	91.4	0.30	1948
3	Building 163	210.0	182.9	96.9	0.30	1955
4	Building 264	218.2	181.4	103.6	0.36	1959

[a] AMSL = above mean sea level.

[b] bgs = below ground surface.

[c] Well not operational.

All radiological results were within their normal range of concentrations as compared with previous results. No VOCs were detected.

6.1.2. Dolomite Well Monitoring

Past analytical data were used to track the presence of hydrogen-3 in ANL-E domestic Well 1 and at a lower concentration in Well 2. It is speculated that the source of the hydrogen-3 was liquid waste placed in an unlined holding pond in the wastewater treatment area (Location 10M in Figure 1.1) in the 1950s. The hydrogen-3 as tritiated water appeared to have migrated through the glacial drift to the dolomite aquifer and was drawn into the wells. Well 1, which is about 200 m (650 ft) north of the wastewater treatment area, had higher hydrogen-3 concentrations than Well 2, which is about 300 m (1,000 ft) from the treatment area. Hydrogen-3 is only occasionally identified at concentrations just above the detection limit because of dilution and radioactive decay. Although the normal subsurface water flow gradient is toward the south-southeast, the cone of depression created by pumping these wells while they were still in use would overpower the normal flow pattern.

With the conversion of local well water to Lake Michigan water in early 1997, the water table elevations began to recover. ANL-E was concerned that the direction of subsurface migration of radionuclides, particularly hydrogen-3, could change because of the lack of the influence of pumping. Since hydrogen-3 from the 570 Area Pond was already known to have migrated to the dolomite, a monitoring network of three ANL-E and seven forest preserve wells was established to monitor the magnitude and direction of hydrogen-3 movement in this area. The well locations are

TABLE 6.2

Radioactivity in ANL-E Former Water Supply Wells, 2002
(Concentrations in pCi/L)

Type of Activity	Location	No. of Samples	Average	Minimum	Maximum
Alpha	Well 1	4	2.9	2.0	3.7
	Well 3	4	2.0	1.6	2.3
	Well 4	4	3.0	2.2	3.6
Beta	Well 1	4	7.5	6.6	8.3
	Well 3	4	8.2	7.2	9.2
	Well 4	4	8.7	7.9	9.4
Hydrogen-3	Well 1	4	< 100	< 100	114
	Well 3	4	< 100	< 100	< 100
	Well 4	4	< 100	< 100	< 100
Strontium-90	Well 1	4	< 0.25	< 0.25	< 0.25
	Well 3	4	< 0.25	< 0.25	< 0.25
	Well 4	4	< 0.25	< 0.25	< 0.25
Radium-226	Well 1	1	-[a]	-	0.70
	Well 3	1	-	-	0.46
	Well 4	1	-	-	1.30
Radium-228	Well 1	1	-	-	0.80
	Well 3	1	-	-	0.39
	Well 4	1	-	-	0.90
Uranium-234	Well 1	1	-	-	0.80
	Well 3	1	-	-	0.23
	Well 4	1	-	-	0.18
Uranium-235	Well 1	1	-	-	0.02
	Well 3	1	-	-	< 0.01
	Well 4	1	-	-	< 0.01
Uranium-238	Well 1	1	-	-	0.51
	Well 3	1	-	-	0.12
	Well 4	1	-	-	0.10

[a] A hyphen indicates that for a single result, the value is placed in the maximum column.

shown in Figure 6.l. Samples were collected quarterly and analyzed for hydrogen-3. Table 6.3 shows the results for 2002. Hydrogen-3 was noted at very low levels in several wells during the year. On the basis of elevated levels in the trip blank samples, it is suspected that the apparent measurable levels of hydrogen-3 are due to laboratory contamination. The source of hydrogen-3 contamination has been identified, and changes to the laboratory operating methods have been changed.

6.2. Groundwater Monitoring at Waste Management Sites

ANL-E has occupied its current site since 1948. Since that time, waste generated by ANL-E was placed in a number of on-site disposal units; these ranged from ditches filled with construction and demolition debris during the 1950s, to a former sanitary landfill used for nonhazardous solid waste disposal until September 1992. Several of these units contain significant amounts of hazardous materials and, therefore, represent a potential threat to the environment. Groundwater below these sites is monitored routinely to assess the amount and nature of hazardous chemical releases from these units. Routinely monitored sites include the sanitary landfill in the 800 Area and the 317/319 ENE Area, which consists of seven separate waste management units located within a small geographical area. The site of the CP-5 reactor is also monitored periodically to determine whether any radionuclides are being released from this unit. To aid the reader, results presented in the well tables that exceed State of Illinois' Class I Groundwater Quality Standards are in bold type.

6.2.1. 317 and 319 Areas

The 317 and 319 Areas contain seven separate current or former units that have been used in the past for handling or disposal of various types of waste. The 317 Area is currently an active radioactive waste processing and storage area. It includes the North Vault, an in-ground vault that was emptied in May 2001 and has remained empty since. The Deep Vault was demolished and backfilled during 2002. The area also contains a small building used for decontamination of metal objects, such as lead bricks, tools, metal objects, etc. In the past, the 317 Area was used for disposal of various liquid chemical wastes in a unit known as a French drain. The drain consisted of a shallow trench filled with gravel into which an unknown quantity of liquid wastes was poured. This unit was operational during the late 1950s. Because of these past disposal practices, there is a region of contaminated soil in the north half of the 317 Area. The contaminants are primarily VOCs such as cleaning solvents. The groundwater below this area also contains concentrations of these chemicals. General features in the 317/319 Area are identified in Figure 6.2.

The groundwater below the 317/319 Area exists in several shallow (3 to 16 m [10 to 50 ft]) sand and gravel units up to 6-m (20-ft) thick within the glacial drift, as well as in the upper portions of the dolomite bedrock. There are no known consumers of this groundwater downgradient of the ANL-E site.

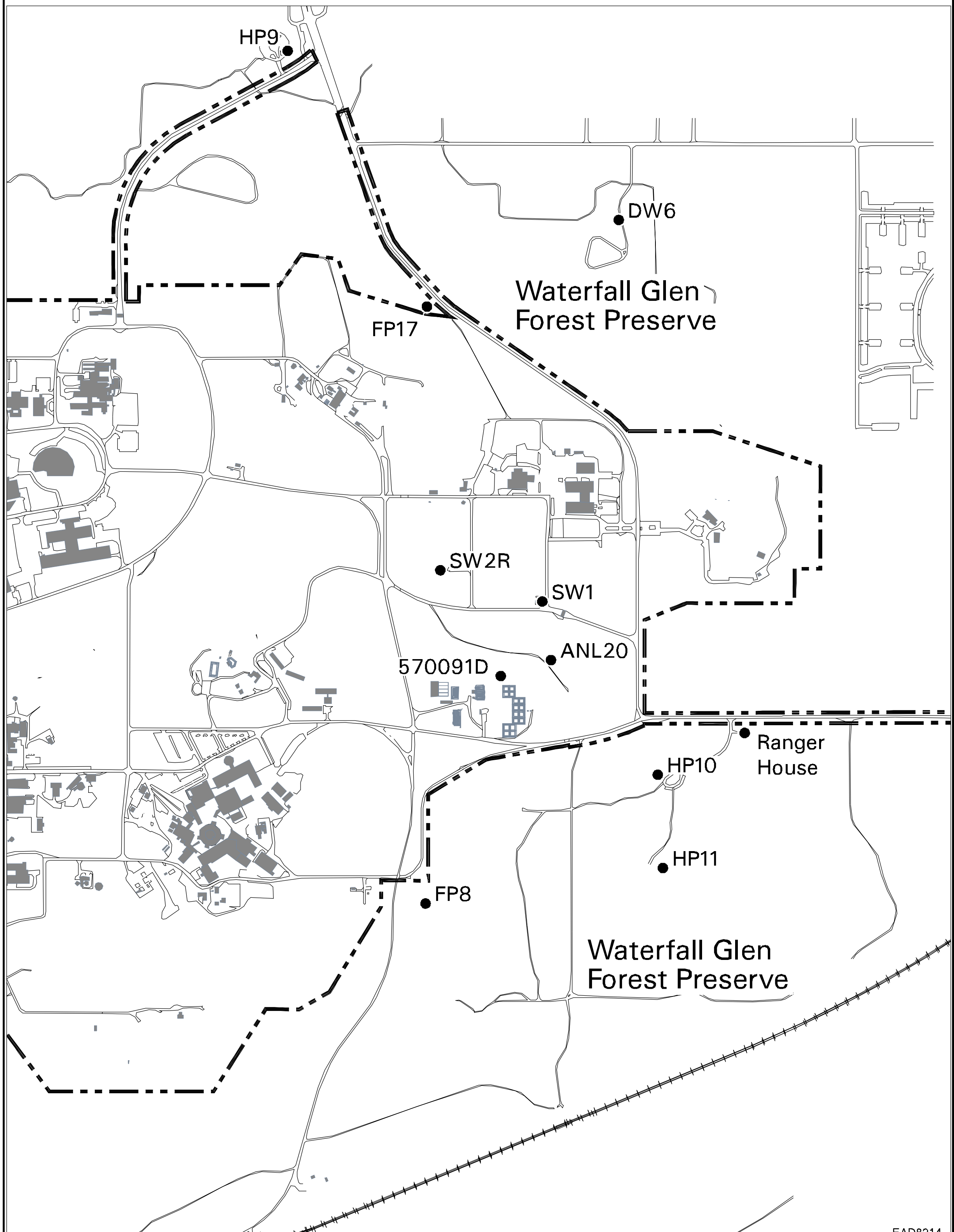


Figure 6.1 East Area/Forest Preserve Monitoring Wells

TABLE 6.3

Hydrogen-3 in Dolomite Wells, 2002
(Concentrations in pCi/L)

	Date Collected			
Well	01/25/02	05/08/02	08/21/02	11/05/02
Waterfall Glen				
DW 6	<100	<100	<100	<100
HP 9	<100	<100	<100	121
HP 10	168	<100	<100	106
HP 11	<100	<100	<100	<100
FP 8	<100	<100	<100	<100
FP 17	<100	128	<100	<100
Ranger House	<100	<100	<100	178
ANL-E				
5700910	<100	<100	<100	170
ANL-20	<100	143	<100	<100
SW2R	<100	<100	<100	105
Trip Blank	<100	<100	117	138

The 319 Area contains an inactive landfill that was used for disposal of a variety of solid wastes generated on site prior to 1969. It was not intended for disposal of radioactive waste; however, a small amount of radioactive material was detected during sampling activities completed several years ago. The only radionuclide found to be migrating from the landfill is hydrogen-3, although strontium-90 was noted one quarter in a well south of the 319 Area. The 319 waste burial area consists of two distinct segments: the waste mound, where the bulk of the waste was buried, and an adjacent burial trench, which contains a much smaller amount of mostly inert waste. This landfill also contains a French drain that was used for several years after the French drain in the 317 Area was closed. The presence of liquid chemical wastes from the French drain, as well as hydrogen-3 in the waste mound, have resulted in the generation of a plume of contaminated groundwater extending from the waste mound to the south, toward the Des Plaines River.

During late 1996, a series of small natural groundwater discharge points (groundwater seeps) was discovered approximately 183 m (600 ft) south of the 319 Area. Two of these seeps were found to contain low levels of three VOCs. These two seeps and one additional seep, which normally does not contain VOCs, were found to contain hydrogen-3 at concentrations below all applicable standards. Since their discovery, these seeps have been monitored on a regular basis (see Section 6.5). A characterization study was completed in 1998 to identify the source and migration pathways for the hydrogen-3 and VOCs. The hydrogen-3 appears to be emanating from the 319 Landfill and is likely an extension of the on-site hydrogen-3 plume, albeit at much lower

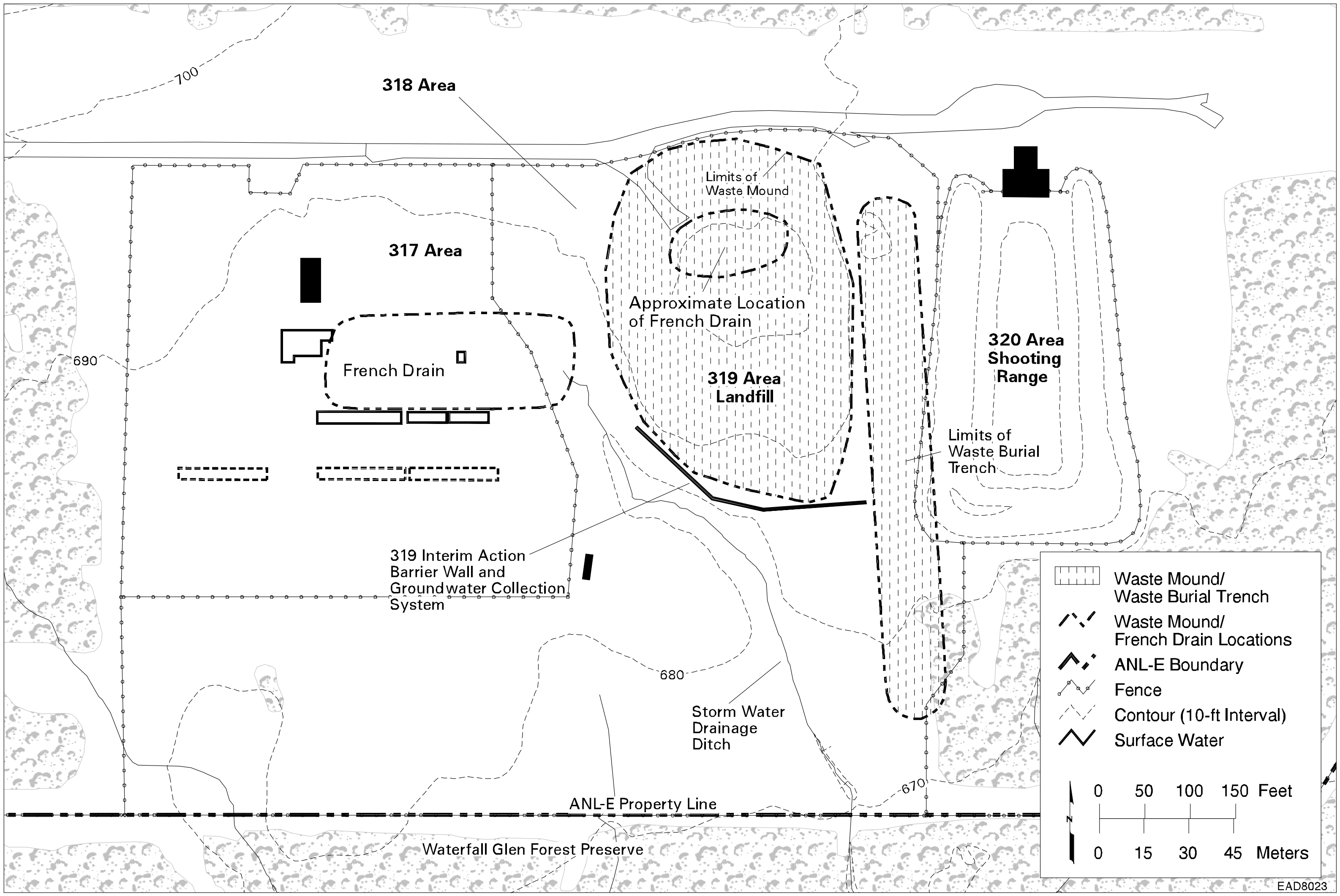


Figure 6.2 Locations of Components within the 317/319/ENE Area

concentrations than measured on site. The source of VOCs was not clearly discerned, though it is likely that they also emanated from some past waste disposal activities in the 319 or 317 Area. The known extent of contaminated groundwater covers much of the area from the 317 French Drain and 319 Landfill, southeast to the seeps.

Cleanup of the 317 and 319 Areas has been underway since the late 1980s. It is being carried out as a series of interrelated actions that will ultimately remove or contain the contaminants so that they will no longer migrate away from the waste disposal units. Several remedial actions are already in place and functioning as designed. These actions include a leachate and groundwater collection system for the 319 Landfill, capping of the 319 Landfill, demolition of five waste storage vaults contaminated with radioactive materials, sealing of an underground drainage system, installation of 15 groundwater extraction wells south of the 317 Area, construction of a concrete cover over a region containing buried compressed gas cylinders (318 Area), treating highly contaminated soil near the former French drain, and phytoremediation of residual soil and groundwater contamination. Routine sampling and analysis of groundwater and surface water have continued.

During 2002, extensive remedial actions were begun on the 317 Area Deep Vault and 317 Area concrete storage pad. The Deep Vault was demolished and backfilled. The storage pad and contaminated soil beneath the pad were removed. The concrete from the demolished pad was used as part of the backfill for the vault. The storage pad was closed.

The North Vault was repaired because ANL-E has decided to continue storing waste in the vault. Part of the north wall of the vault was rebuilt, and new roof covers were fabricated.

In 1999, the IEPA approved the installation of a phytoremediation system in the 317 Area. Phytoremediation involves the use of green plants (trees, grasses, and flowering plants) to remove contaminated groundwater by evapotranspiration and to degrade contaminants in soil and groundwater. A dense planting of willow trees in the vicinity of the 317 French Drain and a larger planting of hybrid poplar trees downgradient of the 317 French Drain and the former 319 Landfill are in place and will be monitored over the next several years for their ability to remediate those areas.

The results of the required routine monitoring of the groundwater collection systems in the 317 and 319 Areas, the phytoremediation system, and the monitoring of the off-site groundwater seeps continue to be transmitted to the IEPA on a quarterly basis through the submittal of Quarterly Progress Reports. The results of this monitoring are too numerous to include in this report; however, the general conclusions are discussed below.

6.2.2. Groundwater Monitoring at the 317 and 319 Areas

Groundwater monitoring in the 317 and 319 Areas as part of the sitewide monitoring and surveillance program has been conducted since 1986. Wells 319011, 317021, and 319031 were installed in September 1986; Well 317061 was originally installed in August 1987 but replaced in May 2000; Wells 317101 and 317111 were installed in September 1988; and Wells 319032 and 317052 were installed in June 1989 (Figure 6.3). These wells were all completed in the glacial drift. Wells 317121D and 319131D were installed in November 1989 and reach the dolomite aquifer at about 20 m (64 ft) below the surface.

Wells 317101 and 317111 are upgradient of the 317 storage area, and Well 319011 is upgradient of the 319 Area Landfill. A sand lens present at 5 to 8 m (15 to 25 ft) is monitored by Wells 317052, 319031, 319032, and 317021. Groundwater in the dolomite bedrock aquifer is monitored at Wells 317121D and 319131D. Table 6.4 lists well data for these areas. These wells are not used to monitor the progress of specific systems, but rather serve the 317/319 Area as a whole. In addition to wells in this area, two manholes associated with the vault sewer system were monitored on a monthly basis. Figure 6.3 shows the locations of the manholes.

TABLE 6.4

Groundwater Monitoring Wells: 317 and 319 Areas

ID Number	Well Depth (m bgs)	Ground Elevation (m AMSL)	Monitoring Zone (m AMSL)	Well Type[a]	Date Drilled
319011	12.19	209.8	199.1–197.6	0.05/PVC	9/86
317021	12.19	209.2	198.5–197.0	0.05/PVC	9/86
319031	12.50	204.3	194.8–191.8	0.05/PVC	9/86
319032	7.62	204.3	198.2–196.7	0.05/PVC	6/89
317052	4.27	208.3	207.1–204.0	0.05/PVC	6/89
317061[b]	10.36	207.6	197.3–199.7	0.05/PVC	5/00
317101	11.89	211.0	202.2–199.1	0.05/PVC	9/88
317111	11.89	210.3	201.4–198.4	0.05/PVC	9/88
317121D[c]	24.08	207.6	185.0–183.5	0.15/CS	11/89
319131D	21.03	203.5	184.0–182.5	0.15/CS	11/89

[a] Inner diameter (m)/well material (PVC = polyvinyl chloride, CS = carbon steel).

[b] Well was replaced when original well was damaged and became inoperable.

[c] Wells identified by a “D” are deeper wells monitoring the dolomite bedrock aquifer.

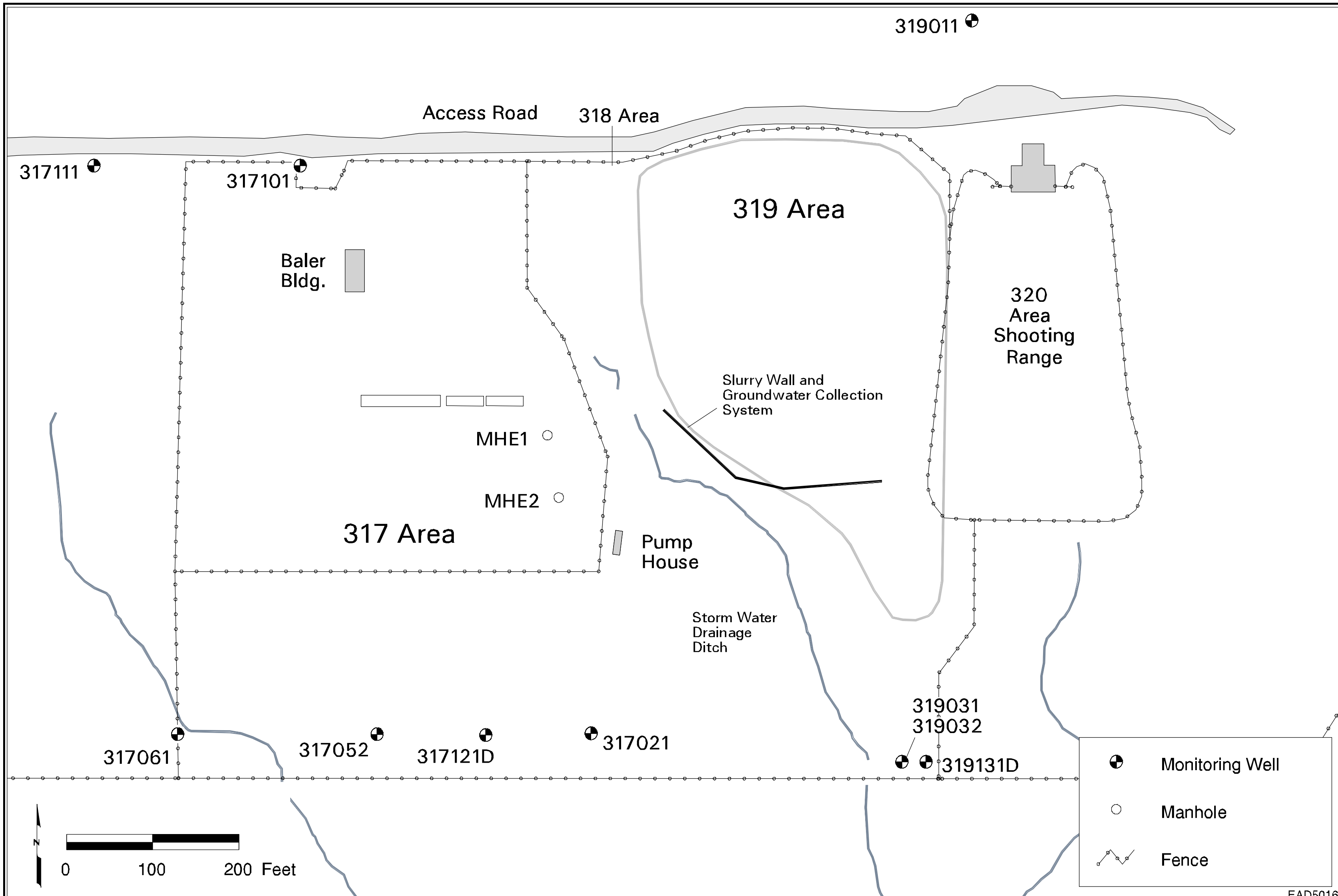


Figure 6.3 Monitoring and Characterization Wells in the 317 and 319 Areas, 2002

The remedial actions program collects groundwater data from an extensive network of wells located throughout the 317 and 319 Areas. These data are transmitted to the IEPA quarterly. For clarity, these other wells are not shown in Figure 6.3. To monitor the performance of the various remedial actions constructed in the 317 and 319 Areas, samples are collected on a quarterly basis, and the results are transmitted to the IEPA each quarter. The purpose of this monitoring is to track the movement of contaminated groundwater and to determine the rate at which contaminant levels are decreasing. Monitoring results in 2002 indicate that the two groundwater collection systems south of the 319 Landfill and south of the 317 Area are effectively preventing off-site migration of contaminated groundwater. The analysis of groundwater samples for contaminants reveals that high concentrations of VOCs are present in groundwater in the immediate vicinity of the former 317 Area French Drain. Concentrations of up to 340,000 µg/L of chlorinated VOCs (i.e., carbon tetrachloride) were detected. However, at the ANL-E fence line, near the groundwater collection wells, the level of contamination is much lower; the highest concentration noted in 2002 was 490 µg/L of 1,1,1-trichloroethane. This groundwater is being collected by the extraction system so that it does not migrate off site.

Plant tissue monitoring at the phytoremediation system indicates that the trees are indeed taking up the organic materials and breaking them down within the trees. The effect of the trees on groundwater movement was also measured; however, the trees are not full grown, so that their effect was not great enough to be easily measured. Long-term monitoring of this system will determine its effectiveness at removing groundwater and degrading contaminants.

6.2.2.1. Sample Collection

The monitoring wells are sampled using the protocol listed in the *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*.[29] The volume of the water in the casing is determined by measuring the water depth from the surface and the depth to the bottom of the well. This latter measurement also determines whether siltation has occurred, which might restrict water movement in the screened area. For those wells in the glacial drift that do not recharge rapidly, the well is emptied and the volume of water removed is compared with the calculated volume. In most cases, these volumes are nearly identical. The well is then sampled, following recovery, by bailing with a dedicated Teflon bailer. The field parameters for these samples (pH, specific conductance, redox potential, and temperature) are measured statically. For those samples in the porous, saturated zone that recharges rapidly, three well volumes are purged using dedicated submersible pumps, while the field parameters are measured continuously. These parameters stabilize quickly in these wells. In the case of the dolomite wells, samples are collected as soon as these readings stabilize. Samples for VOCs, SVOCs, PCBs and pesticides, metals, nonmetals, and radioactivity are collected in that order. The samples are placed in precleaned bottles, labeled, and preserved.

During each sampling event, one well is selected for replicate sampling. An effort is made to vary this selection so that replicates are obtained at every well over time. In addition, a field blank is also prepared.

6.2.2.2. Sample Analyses - 317 and 319 Areas

The 317 and 319 Area groundwater chemical analyses were performed using SOPs written, reviewed, and issued as controlled documents by members of the Chemical Engineering Division, ESH Analytical Chemistry (CMT/ESH-AC). These SOPs reference protocols in SW-846.[6] Fifteen metals were routinely measured using inductively coupled plasma atomic emission spectrometry and graphite furnace atomic absorption spectroscopy. Mercury was determined by cold vapor atomic absorption spectroscopy. Chloride was determined by titrimetry. VOCs were determined by using a purge and trap sample pretreatment followed by gas chromatography-mass spectroscopy detection. SVOCs were determined by solvent extraction followed by gas chromatography-mass spectrometry detection. PCBs and pesticides were determined by solvent extraction followed by gas chromatography-electron capture detection.

The 317 and 319 Area groundwater radiological analyses were performed using SOPs written, reviewed, and issued as controlled documents by members of CMT/ESH-AC. Cesium-137 was determined by gamma-ray spectrometry. Hydrogen-3 was determined by distillation followed by a beta liquid scintillation counting technique. Strontium-90 was determined by an ion-exchange separation followed by a proportional counting technique.

6.2.2.3. Results of Analyses

Descriptions of each well, the field parameters measured during sample collection, and the results of chemical and radiological analyses of samples from the wells in the 317 and 319 Areas are contained in Tables 6.5 through 6.14. All radiological and inorganic analytical results are shown in these tables. The analytical methods used for organic compounds could identify and quantify all the compounds contained in the CLP Target Compound List. However, the vast majority of these compounds were not detected in the samples. To simplify the format of these tables, those results less than the detection limit are not included. Only those constituents that were present in amounts great enough to quantify are shown. The detection limits for the organic compounds listed were typically 1 to 10 µg/L. To aid the reader, all results that exceed State of Illinois Class I Groundwater Quality Standards appear in bold.

Field Parameters. The purging of wells to produce water representative of the groundwater being studied was followed by measuring the field parameters. For the wells reported in this study, temperature, pH, redox potential, and specific conductance remained fairly constant

TABLE 6.5

Groundwater Monitoring Results, 300 Area Well 317021, 2002

Parameter	Units	Date of Sampling 02/04/02	05/07/02	09/09/02	09/09/02	10/23/02
Water elevation[a]	m	198.91	199.86	199.00	199.00	198.67
Temperature	°C	9.6	11.0	13.0	13.0	10.1
pH	pH	7.11	7.24	7.08	7.08	7.44
Redox	mV	3	-15	-27	-27	-21
Conductivity	µmhos/cm	808	884	1,041	1,041	990
Chloride[b]	mg/L	41	27	64	67	42
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0374	0.0365	0.0455	0.0458	0.0428
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.0476	< 0.02	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0118	< 0.008	0.0237	0.03	0.0387
Americium-241	fCi/L	-[c]	-	-	-	< 1.0
Curium-242	fCi/L	-	-	-	-	< 1.0
Curium-244	fCi/L	-	-	-	-	< 1.0
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	187	188	120	< 100	< 100
Neptunium-237	fCi/L	-	-	-	-	< 1.0
Plutonium-238	fCi/L	-	-	-	-	< 1.0
Plutonium-239	fCi/L	-	-	-	-	< 1.0
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25
1,1,1-Trichloroethane	µg/L	2	2	3	3	4
1,1-Dichloroethane	µg/L	1	< 1	1	1	2

[a] Well point elevation = 197.27 m(MSL); ground surface elevation = 209.17 m(MSL); casing material = PVC.
[b] Filtered sample.
[c] A hyphen indicates that no samples were collected.

TABLE 6.6

Groundwater Monitoring Results, 300 Area Well 317052, 2002

		Date of Sampling			
Parameter	Unit	02/05/02	05/07/02	09/09/02	10/23/02
Water elevation[a]	m	204.85	205.75	204.42	204.30
Temperature	°C	8.8	9.0	15.3	14.4
pH	pH	7.33	7.22	7.43	7.06
Redox	mV	-12	-14	-47	-1
Conductivity	µmhos/cm	857	870	980	957
Chloride[b]	mg/L	23	28	45	29
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0335	0.0357	0.0553	0.0487
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.0405	0.1234	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0243	0.0268	**0.2720**[c]	**0.3876**
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	0.0118	0.0136
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	118	195	315	284
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25

[a] Well point elevation = 204.04 m (MSL); ground surface elevation = 208.32 m (MSL); casing material = PVC.

[b] Filtered sample.

[c] Bold type indicates that the value exceeds the State of Illinois Class I Groundwater Quality Standard.

TABLE 6.7

Groundwater Monitoring Results, 300 Area Well 317061, 2002

		Date of Sampling			
Parameter	Unit	01/31/02	05/07/02	09/03/02	10/22/02
Water elevation[a]	m	197.98	199.32	197.91	197.82
Temperature	°C	10.6	11.0	11.9	11.0
pH	pH	7.26	7.02	7.31	7.16
Redox	mV	-6	-4	-32	-7
Conductivity	µmhos/cm	938	978	1,088	1,019
Chloride[b]	mg/L	11	32	16	17
Arsenic[b]	mg/L	0.0148	0.0129	0.0101	0.0099
Barium[b]	mg/L	0.0630	0.0584	0.0612	0.0582
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.0508	< 0.02	< 0.02	0.0212
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0177	0.0159	0.0173	0.0166
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	< 100	< 100	102	< 100
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25

[a] Well point elevation = 197.26 m (MSL); ground surface elevation = 207.62 (MSL); casing material = PVC.

[b] Filtered sample.

TABLE 6.8

Groundwater Monitoring Results, 300 Area Well 317101, 2002

		Date of Sampling			
Parameter	Unit	01/31/02	05/06/02	09/09/02	10/22/02
Water elevation[a]	m	202.34	204.17	202.46	202.14
Temperature	°C	12.0	12.2	12.7	12.1
pH	pH	7.02	7.00	6.83	7.02
Redox	mV	7	5	-14	2
Conductivity	µmhos/cm	2,360	2,750	2,090	1,582
Chloride[b]	mg/L	**462**[c]	**675**	**376**	148
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0922	0.0918	0.0748	0.0573
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.0217	0.0215	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0321	0.0128	< 0.01	0.0383
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	0.0109	< 0.008
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25

[a] Well point elevation = 198.66 m (MSL); ground surface elevation = 211.04 m (MSL); casing material = PVC.

[b] Filtered sample.

[c] Bold type indicates that the value exceeds the State of Illinois Class I Groundwater Quality Standard.

TABLE 6.9

Groundwater Monitoring Results, 300 Area Well 317111, 2002

		Date of Sampling			
Parameter	Unit	01/31/02	05/07/02	09/03/02	10/22/02
Water elevation[a]	m	199.68	201.49	199.92	199.48
Temperature	°C	10.5	11.2	12.0	11.1
pH	pH	7.05	7.00	6.95	7.10
Redox	mV	4	0	-19	-2
Conductivity	µmhos/cm	1,312	1,213	1,279	1,304
Chloride[b]	mg/L	175	187	161	109
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0835	0.0722	0.0774	0.0816
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.0817	0.0282	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0106	0.0851	0.0254	0.0498
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25

[a] Well point elevation = 198.37 m (MSL); ground surface elevation = 210.25 m (MSL); casing material = PVC.

[b] Filtered sample.

TABLE 6.10

Groundwater Monitoring Results, 300 Area Well 317121D, 2002

Parameter	Unit	Date of Sampling				
		02/05/02	02/05/02	05/07/02	09/09/02	10/23/02
Water elevation[a]	m	186.43	186.43	186.48	186.43	186.38
Temperature	°C	8.7	8.7	11.4	11.2	10.5
pH	pH	7.34	7.34	**10.64**[b]	8.92	7.38
Redox	mV	-12	-12	-209	-132	-17
Conductivity	µmhos/cm	719	719	560	448	829
Chloride[c]	mg/L	51	50	42	39	34
Arsenic[c]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium[c]	mg/L	0.0343	0.0324	0.0493	0.0568	< 0.01
Beryllium[c]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[c]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[c]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[c]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[c]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[c]	mg/L	0.0401	< 0.02	0.0353	< 0.02	< 0.02
Lead[c]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[c]	mg/L	0.0101	< 0.01	< 0.01	< 0.01	< 0.01
Mercury[c]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[c]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Silver[c]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[c]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[c]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[c]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	< 100	< 100	131	240	< 100
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25

[a] Well point elevation = 183.49 m (MSL); ground surface elevation = 207.57 m (MSL); casing material = steel.

[b] Bold type indicates that the value exceeds the State of Illinois Class I Groundwater Quality Standard.

[c] Filtered sample.

TABLE 6.11

Groundwater Monitoring Results, 300 Area Well 319011, 2002

Parameter	Unit	Date of Sampling				
		01/31/02	05/06/02	09/03/02	09/03/02	10/22/02
Water elevation[a]	m	200.60	203.32	204.41	204.41	201.84
Temperature	°C	10.6	11.9	13.2	13.2	11.1
pH	pH	7.23	6.80	7.03	7.03	7.10
Redox	mV	-4	12	-22	-22	-4
Conductivity	µmhos/cm	945	907	996	996	997
Chloride[b]	mg/L	46	43	34	35	22
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0393	0.0390	0.0395	0.0381	0.0409
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.0452	0.0252	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0244	0.0244	0.0389	0.0658	0.0329
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0193	< 0.008	0.014	< 0.008	< 0.008
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	< 100	< 100	114	< 100	< 100
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25

[a] Well point elevation = 197.60 m (MSL); ground surface elevation = 209.81m (MSL); casing material = PVC.

[b] Filtered sample.

TABLE 6.12

Groundwater Monitoring Results,
300 Area Well 319031, 2002

Parameter	Unit	Date of Sampling 05/07/02
Water elevation[a]	m	193.11
Temperature	°C	11.4
pH	pH	7.02
Redox	mV	-1
Conductivity	µmhos/cm	833
Chloride[b]	mg/L	27
Arsenic[b]	mg/L	< 0.003
Barium[b]	mg/L	0.048
Beryllium[b]	mg/L	< 0.0002
Cadmium[b]	mg/L	< 0.0002
Chromium[b]	mg/L	< 0.024
Cobalt[b]	mg/L	< 0.016
Copper[b]	mg/L	< 0.015
Iron[b]	mg/L	0.0482
Lead[b]	mg/L	< 0.002
Manganese[b]	mg/L	< 0.01
Mercury[b]	mg/L	< 0.0001
Nickel[b]	mg/L	< 0.02
Silver[b]	mg/L	< 0.001
Thallium[b]	mg/L	< 0.002
Vanadium[b]	mg/L	< 0.032
Zinc[b]	mg/L	0.0263
Cesium-137	pCi/L	< 2.0
Hydrogen-3	pCi/L	686
Strontium-90	pCi/L	0.26
1,1,1-Trichloroethane	µg/L	1
Trichloroethene	µg/L	2

[a] Well point elevation = 191.78 m (MSL); ground surface elevation = 204.28 m (MSL); casing material = PVC.

[b] Filtered sample.

TABLE 6.13

Groundwater Monitoring Results, 300 Area Well 319032, 2002

Parameter	Unit	Date of Sampling 02/04/02	05/07/02	09/09/02	10/23/02
Water elevation[a]	m	197.41	198.28	197.24	196.96
Temperature	°C	10.1	10.6	11.5	11.2
pH	pH	6.96	7.22	7.06	7.08
Redox	mV	10	-12	-25	-1
Conductivity	μmhos/cm	911	922	991	1,006
Chloride[b]	mg/L	16	12	15	10
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0619	0.0684	0.0702	0.0661
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0221	< 0.0080	0.0084	0.0123
Americium-241	fCi/L	-[c]	-	< 1.0	-
Curium-242	fCi/L	-	-	< 1.0	-
Curium-244	fCi/L	-	-	< 1.0	-
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	133	228	301	291
Neptunium-237	fCi/L	-	-	< 1.0	-
Plutonium-238	fCi/L	-	-	< 1.0	-
Plutonium-239	fCi/L	-	-	< 1.0	-
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25
1,4-Dioxane	μg/L	< 25	27	< 25	< 25

[a] Well point elevation = 196.66 m (MSL); ground surface elevation = 204.28 m (MSL); casing material = PVC.

[b] Filtered sample.

[c] A hyphen indicates that no samples were collected.

TABLE 6.14

Groundwater Monitoring Results, 300 Area Well 319131D, 2002

Parameter	Unit	Date of Sampling 02/04/02	02/04/02	05/07/02	09/09/02	10/23/02
Water elevation[a]	m	184.41	184.41	184.88	184.42	184.36
Temperature	°C	9.1	9.1	11.6	13.5	11.1
pH	pH	6.83	6.83	7.19	7.07	7.11
Redox	mV	15	15	-12	-29	-8
Conductivity	µmhos/cm	1,044	1,044	967	1,078	1,110
Chloride[b]	mg/L	56	54	59	62	50
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0698	0.0682	0.0747	0.0739	0.0729
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	0.0167	< 0.008
Americium-241	fCi/L	-[c]	-	1.39	-	-
Curium-242	fCi/L	-	-	< 1.0	-	-
Curium-244	fCi/L	-	-	< 1.0	-	-
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	1,135	663	1,004	1,114	1,293
Neptunium-237	fCi/L	-	-	< 1.0	-	-
Plutonium-238	fCi/L	-	-	< 1.0	-	-
Plutonium-239	fCi/L	-	-	< 1.0	-	-
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25

[a] Well bottom elevation = 182.88 m (MSL); ground surface elevation = 203.56 m (MSL); casing material = steel.

[b] Filtered sample.

[c] A hyphen indicates that no samples were collected.

after two well volumes were removed. On the basis of this information, sampling was conducted after the removal of three well volumes. The field parameters listed in the tables are the final readings obtained at the time of sampling. Wells 319011, 317021, 317061, 317111, 319031, and 319131D usually dry up after one well volume is removed. Therefore, field parameters were measured on one well volume. Similar to past years, Well 319031 was dry during the first, third, and fourth quarters. Conductivity was elevated in Wells 317101 and 317111. This is probably related to the fact that chloride levels in these two wells are elevated, and in fact, exceeded the WQS (200 mg/L) in Well 317101. This is due to the fact that both are located near a road that is salted during the winter.

Inorganic Parameters. ANL-E chose a conservative approach for evaluating the monitoring results by selecting as the standard of comparison the Illinois Groundwater Quality Standards for Class I: Potable Resource Groundwater, 31 IAC, Section 620.410. The standards are presented in Tables 6.15 and 6.16. In 2002, all samples for metals analyses were field-filtered prior to preservation with acid (an IEPA requirement for the IEPA-approved groundwater monitoring program at the 800 Area Landfill, Section 6.3.2.3).

As noted in previous years, no elevated levels, with respect to the WQS for inorganics, were noted with the exception of pH at dolomite Well 317121D the second quarter and chloride at Well 317101. Historically, elevated pH values at Well 317121D have been reported. The pH changes drastically between the purging of two to five volumes of water. In each case, the last value obtained was recorded. Well 317101 exceeded the WQS for chloride three quarters. Chloride levels ranged from 148 to 675 mg/L and may be due to road salt. Several wells had elevated levels of barium, iron, and manganese; Well 317052 exceeded the WQS for manganese two quarters. Barium concentrations ranged from less than 0.01 to 0.09 mg/L, iron concentrations ranged from less than

TABLE 6.15

Illinois Class I Groundwater Quality Standards: Inorganics (concentrations in mg/L, except radionuclides and pH)

Constituent	Standard
Antimony	0.006
Arsenic	0.05
Barium	2
Beryllium	0.004
Boron	2
Cadmium	0.005
Chloride	200
Chromium	0.1
Cobalt	1
Copper	0.65
Cyanide	0.2
Fluoride	4
Iron	5
Lead	0.0075
Manganese	0.15
Mercury	0.002
Nickel	0.1
Nitrate, as N	10
Radium-226	20 pCi/L
Radium-228	20 pCi/L
Selenium	0.05
Silver	0.05
Sulfate	400
Thallium	0.002
TDS	1,200
Zinc	5
pH	6.5–9.0

TABLE 6.16

Illinois Class I Groundwater Quality Standards: Organics
(concentrations in mg/L)

Constituent	Standard	Constituent	Standard
Alachlor	0.002	1,1-Dichloroethene	0.007
Aldicarb	0.003	*cis*-1,2-Dichloroethylene	0.07
Atrazine	0.003	*trans*-1,2-Dichloroethylene	0.1
Benzene	0.005	1,2-Dichloropropane	0.005
Benzo(a)pyrene	0.0002	Ethylbenzene	0.7
Carbofuran	0.04	Methoxychlor	0.04
Carbon tetrachloride	0.005	Monochlorobenzene	0.1
Chlordane	0.002	Pentachlorophenol	0.001
Dalapon	0.2	Phenols	0.1
Dichloromethane	0.005	Picloram	0.5
Di(2-ethyhexyl)phthalate	0.006	PCBs (decachlorobiphenyl)	0.0005
Dinoseb	0.007	Simazine	0.004
Endothall	0.1	Styrene	0.1
Endrin	0.002	2,4-5-TP (Silvex)	0.05
Ethylene dibromide	0.00005	Tetrachloroethylene	0.005
Heptachlor	0.0004	Toluene	1
Heptachlor epoxide	0.0002	Toxaphene	0.003
Hexachlorocyclopentadiene	0.05	1,1,1-Trichloroethane	0.2
Lindane	0.0002	1,1,2-Trichloroethane	0.005
2,4-D	0.07	1,2,4-Trichlorobenzene	0.07
o-Dichlorobenzene	0.6	Trichloroethylene	0.005
p-Dichlorobenzene	0.075	Vinyl chloride	0.002
1,2-Dibromo-3-Chloropropane	0.0002	Xylenes	10
1,2-Dichloroethane	0.005		

0.02 to 0.12 mg/L, and manganese concentrations ranged from less than 0.01 to 0.39 mg/L. The source of the elevated levels is unknown. Similar manganese concentrations have been measured at distances from the 317/319 Areas, that is, the CP-5 reactor and 800 Landfill Areas. Elevated levels of barium and manganese have been reported in previous annual reports.[16]

Organic Parameters. No organic WQSs were exceeded in 2002. As in previous years, VOCs were detected in Wells 317021, 319031, and 319032. VOC concentrations were very low. Well 317021 continues to show persistent but very low VOC levels of the same contaminants as in previous years. Historically, Well 319031, although usually dry, contains organic constituents when water is present. As in 2001, 1,4-dioxane was the only VOC noted only one quarter in Well 319032. The reduction in frequency and concentration of VOCs appears to be a result of the extensive remedial actions in the 317 and 319 Areas completed during the last few years. It should be noted that monitoring conducted by the corrective actions group, which is not presented in this report, routinely detects orders of magnitude higher concentrations of VOCs than those described above; many results are well in excess of WQSs. These samples are collected near areas where waste was placed in the ground and where active remediation is being conducted. Higher concentrations at these locations are expected at this point in time.

Once during the year, the wells were sampled and analyzed for SVOCs, PCBs, pesticides, and herbicides. None of these parameters were found in 2002.

Figure 6.4 shows selected VOC results for Well 317021 since 1988. The major components are 1,1,1-trichloroethane (TCA) and 1,1-dichloroethane (DCA); the latter can be a decomposition product of TCA. As shown in Figure 6.4, the concentrations roughly parallel each other, and the levels are consistent until 1991, at which time a trend of increasing, then decreasing concentrations can be observed. Since early 1998, the level of contamination has dropped dramatically. The well is immediately below a former discharge line that was known to be contaminated from leaks in the system. The sewer line was permanently closed in 1986 and sealed in 1997. A groundwater collection system in the vicinity of this well was installed in late 1997.

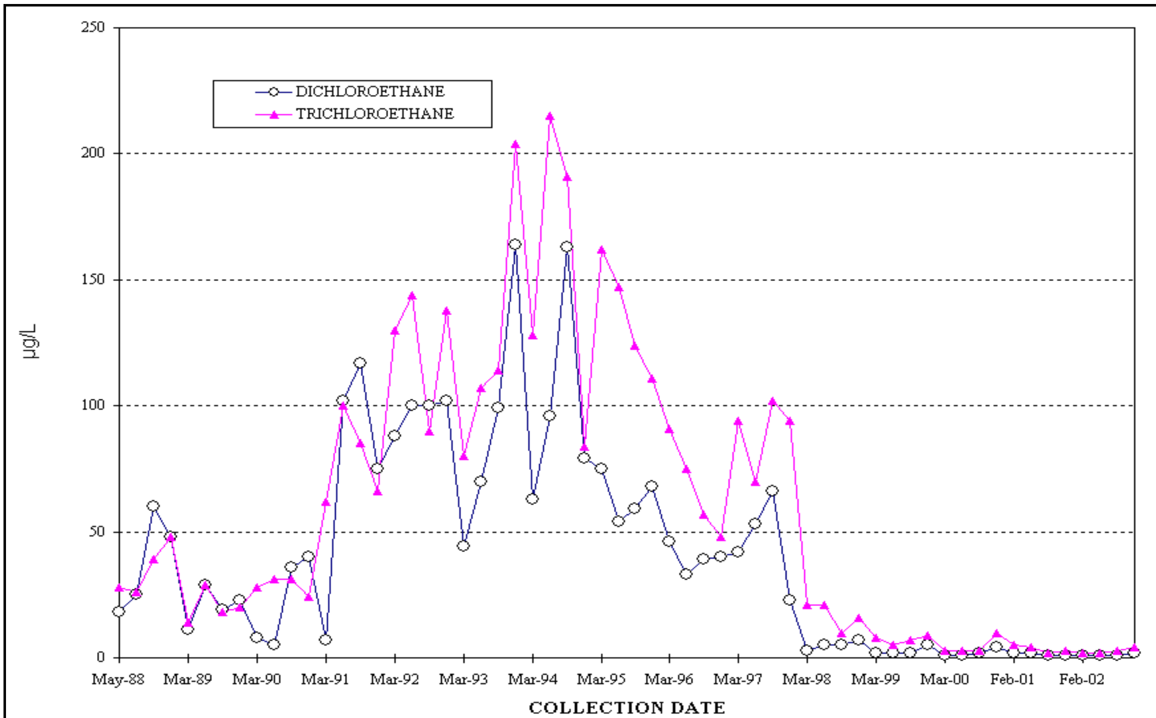


Figure 6.4 Concentrations of 1,1-Dichloroethane and 1,1,1-Trichloroethane in Well 317021

TABLE 6.17

Volatile Organic Compounds in the 317 Area: Manholes E1 and E2, 2002
(Concentrations in µg/L)

Date Collected	Chloroform		Tetra-chloroethene		Trichloro-ethene		*cis*-1,2-Dichloro-ethene		1,1-Dichloro-ethane		Carbon Tetrachloride		1,1,1-Trichloro-ethane	
	E1	E2	E1	E2	E1	E2	E1	E2	E1	E2	E1	E2	E1	E2
01/15/02	17	3	10	2	9	8	3	2	26	27	42	5	50	51
02/11/02	35	7	29	5	15	11	5	4	29	31	88	13	50	57
03/12/02	248	268	20	23	63	72	16	18	23	25	205	248	41	48
04/04/02	118	24	18	6	25	12	9	3	21	21	119	15	37	38
05/14/02	248	125	23	16	35	22	9	5	24	28	202	91	29	35
06/12/02	4	1	6	1	6	6	1	1	14	14	13	2	16	17
07/18/02	64	6	11	3	24	15	4	2	30	32	68	11	61	80
05/05/02	64	2	98	14	13	1	5	1	11	1	322	7	20	1
09/10/02	86	1	12	1	32	6	7	2	13	13	85	1	19	21
10/09/02	192	9	26	5	49	7	12	9	14	6	216	12	37	12
11/13/02	24	9	4	3	6	8	2	5	6	10	29	7	11	16
12/02/02	62	13	11	5	34	12	16	12	9	13	46	11	13	20

Manholes E1 and E2, in the 317 Area were sampled monthly and analyzed for VOCs. The results are presented in Table 6.17. Contributors of groundwater into Manholes E1 and E2 include an average of 739 L/day (195 gal/day) from the 319 Area groundwater collection system, an average of 17,613 L/day (4,649 gal/day) from the 317 Area groundwater collection system, and groundwater from existing 317 Area foundation drains around storage vaults.

Water from the 317 Area and 319 Area groundwater collection systems is pumped to Manhole 2E. Manhole 1E receives water from the 317 Area. Flows from the 319 Area collection system to Manhole 2E have decreased 79% (3,529 L/day to 739 L/day) since 1999. This decrease can be mainly attributed to a considerable drop in groundwater extraction rates due to the addition of the 319 Landfill Cap installed during summer 1999. The flows from the 317 Area groundwater collection system fluctuated over this time period; flows ranged from 29,840 L/day (7,880 gal/day) in 1999, 14,987 L/day (3,958 gal/day) in 2000, 24,465 L/day (6,461 gal/day) in 2001 to 17,613 L/day (4,649 gal/day) in 2002. These flow rates appear to be due to seasonal precipitation fluctuations. For example, the flow rates during the first two quarters of 2002 represented over 81% of the total from the 317 Area. The period of September 2002 through December 2002 was one of the driest periods on record.

In general, VOC concentrations in Manholes E1 and E2 decreased from levels noted in previous years (see Figure 6.5). The decrease is mainly associated with remediation activities in the 317 and 319 Areas. A soil remediation project in the 317 French Drain Area in 1998 resulted in the

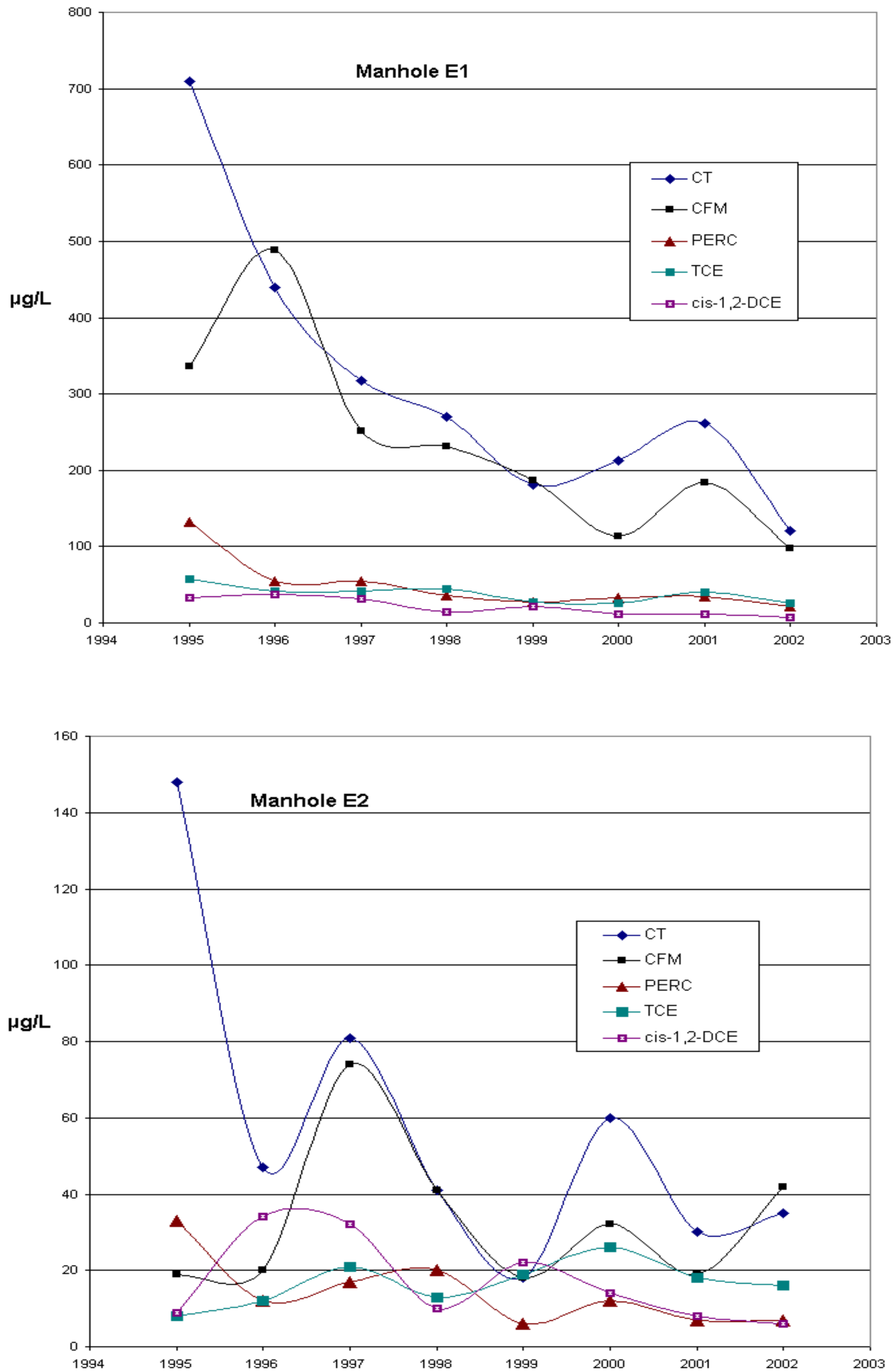


Figure 6.5 Manholes E1 and E2 Annual Average Groundwater Concentrations, 1995 to 2002

removal of approximately 80% of the VOCs from several locations within the 317 French Drain Area. As previously mentioned, the addition of the 319 Landfill Cap in summer of 1999 has decreased leachate production in this area and has resulted in a substantial decrease in the amount of water pumped to Manhole E2 from the 319 Area groundwater collection system. These activities probably account for the decrease in VOC concentrations in Manhole E2 from levels noted in 2000 (see Figure 6.5). Compared to VOC concentrations in 2001 in Manhole E1, VOC levels have decreased. These decreases may be associated with the substantial increase of groundwater extraction from the 317 Area groundwater collection system. Figures 6.6 to 6.12 compare the major VOC concentrations in Manholes E1 and E2. The TCA and DCA levels in both manholes parallel each other (see Figures 6.11 and 6.12).

Radioactive Constituents. Samples collected quarterly from the monitoring wells in the 317 and 319 Areas were analyzed for hydrogen-3, strontium-90, and gamma-ray emitters. An annual sample for alpha emitters was collected from Wells 317021, 319032, and 319131D. The results are presented in Tables 6.5 to 6.14. Evidence of possible off-site migration of radionuclides is noted by the low concentrations of hydrogen-3 and strontium-90 in wells located near the south perimeter fence in the 317 and 319 Areas. As in 2000 and 2001, hydrogen-3 was detected in Wells 317021 and 317121D, located south of the 317 Area. Hydrogen-3 was also noted each quarter in well 317052, which is also located south of the 317 Area near the perimeter fence. Hydrogen-3 was also detected in Wells 319031, 319032, and 319131D, which are located near the south 319 Area perimeter fence. The hydrogen-3 levels were well below the WQS (20,000 pCi/L) and ranged from less than 100 to 1,293 pCi/L. As in previous years, strontium-90 was detected only in Well 319031, which is near the south perimeter fence. The strontium-90 level was well below the WQS (8 pCi/L).

Groundwater monitoring for the remedial actions in the 317 and 319 Areas for hydrogen-3 has identified two areas of elevated hydrogen-3. The first area is immediately under and south of the 319 Landfill. Groundwater concentrations as high as 158,000 pCi/L in this vicinity were measured in 2002. This represents a substantial increase in the high level measured in 2001 (47,400 pCi/L). This increase appears to be due to a lack of dilution resulting from drought conditions during 2002. Downgradient of the 319 Landfill, hydrogen-3 levels are much lower, ranging from about 2,570 pCi/L, 46 m (150 ft) south of the 319 Area, to nondetectable levels closer to the fence line. In the 317 Area, an area of elevated hydrogen-3 exists near the radioactive waste storage vaults. The levels of hydrogen-3 in this area are much lower than in the 319 Area, ranging from 2,080 to 4,670 pCi/L immediately south of the vaults, from nondetectable to 400 pCi/L at the fence line. All hydrogen-3 levels in the 317 Area monitoring wells are below the WQS groundwater quality standards. In general, hydrogen-3 levels in the 317 Area appear to be decreasing; however, long-term monitoring of groundwater is needed to confirm this trend.

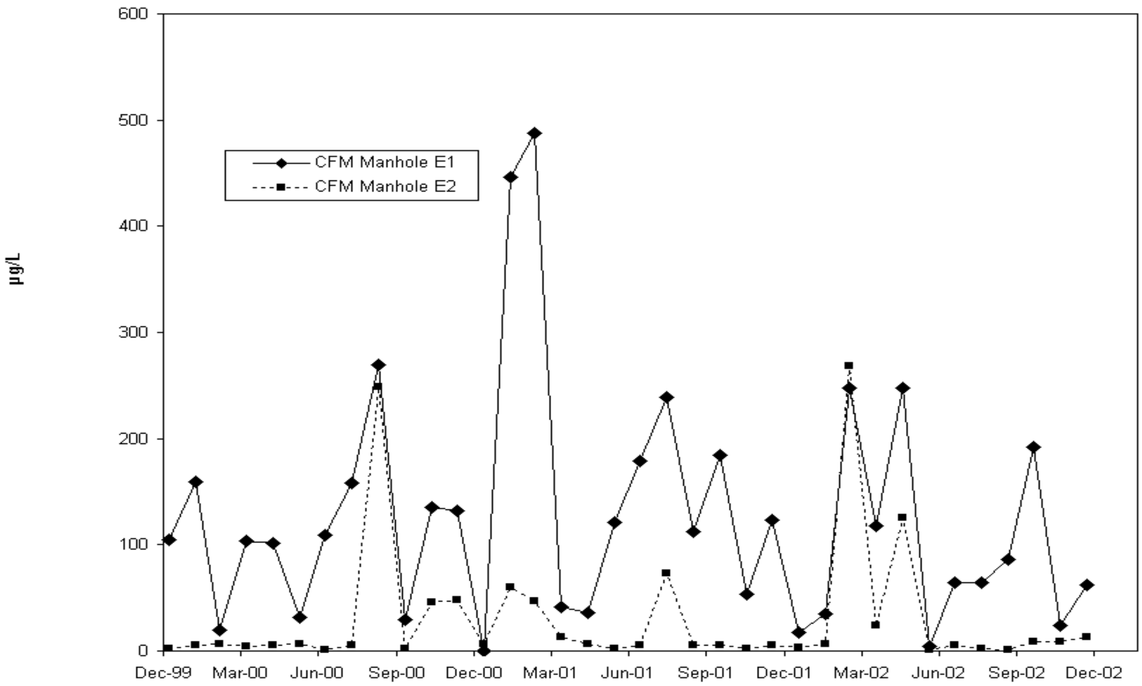


Figure 6.6 Manholes E1 and E2 Chloroform Levels, 2000 to 2002

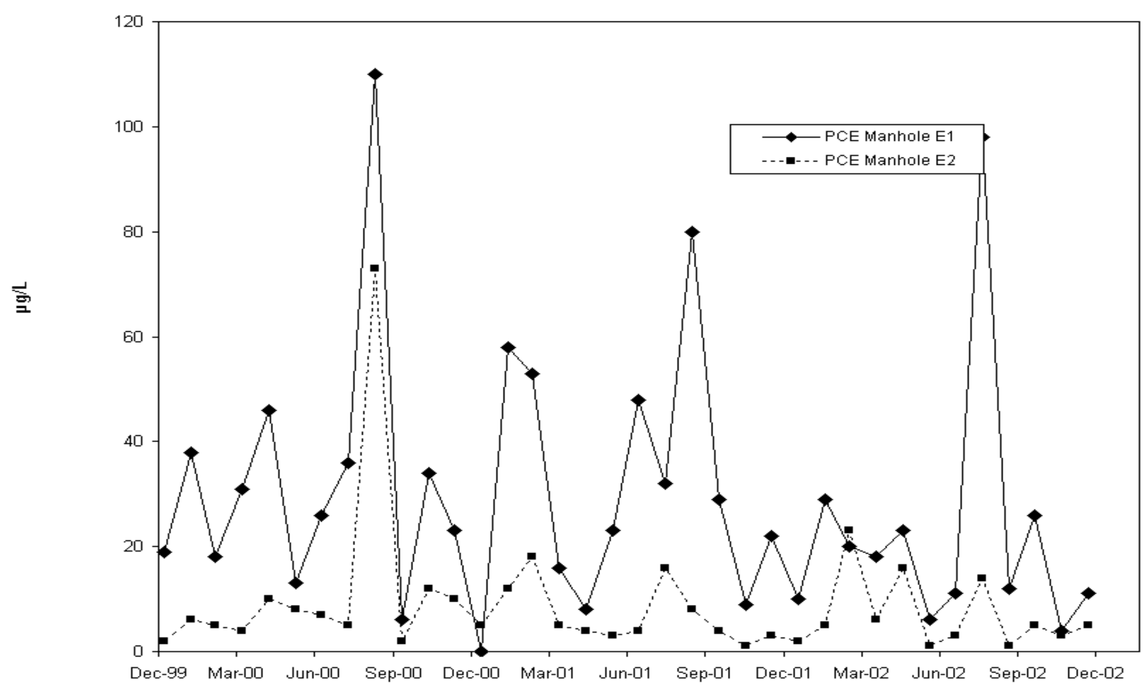


Figure 6.7 Manholes E1 and E2 Tetrachloroethene Levels, 2000 to 2002

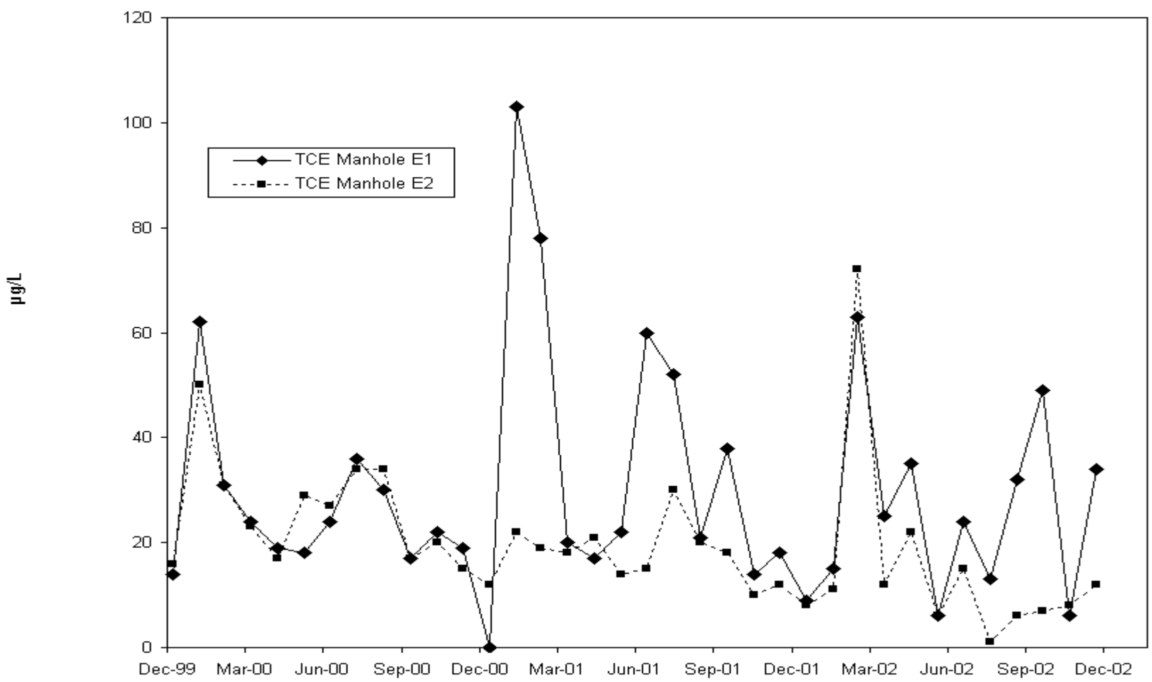


Figure 6.8 Manholes E1 and E2 Trichloroethene Levels, 2000 to 2002

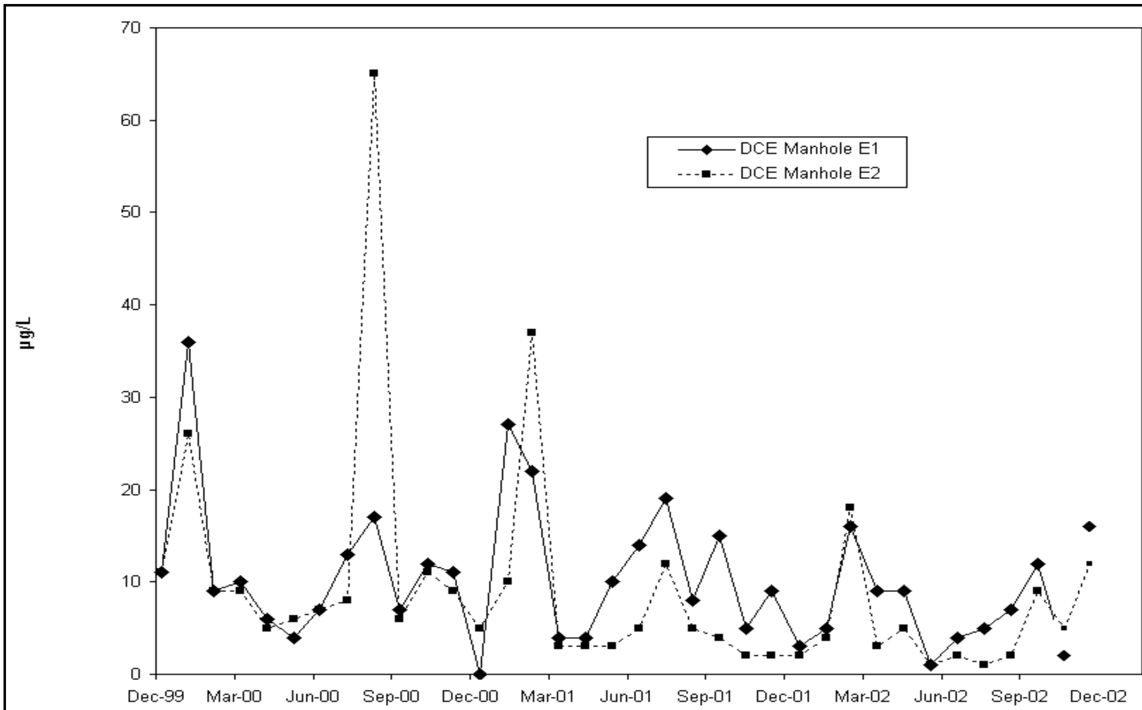


Figure 6.9 Manholes E1 and E2 *cis*-1,2-Dichloroethene Levels, 2000 to 2002

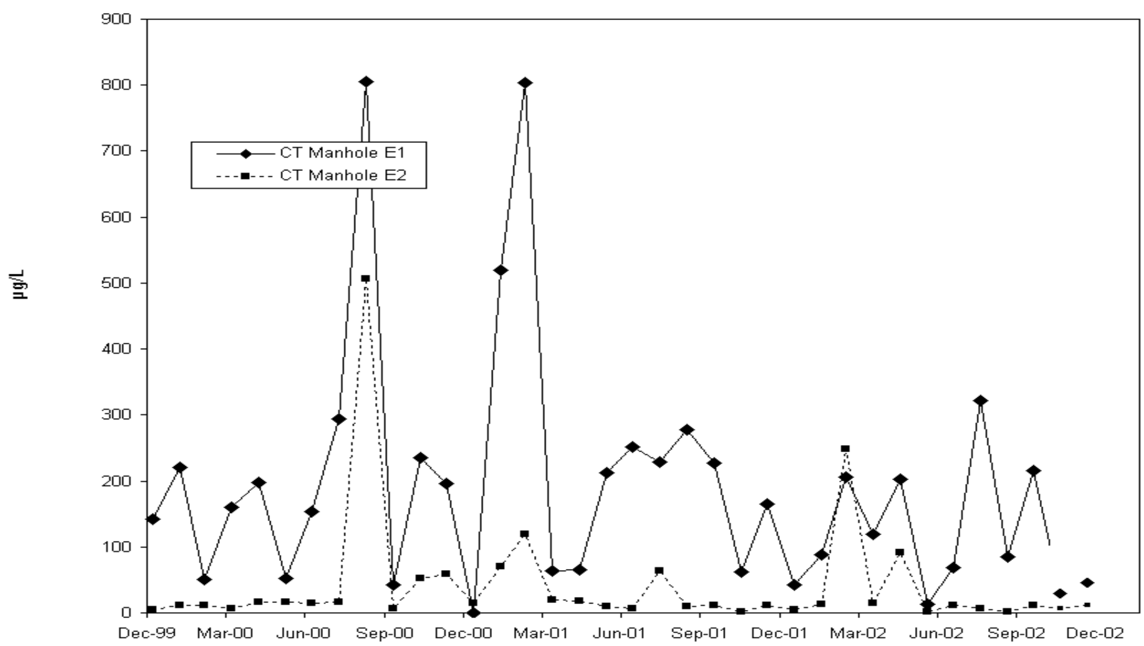


Figure 6.10 Manholes E1 and E2 Carbon Tetrachloride Levels, 2000 to 2002

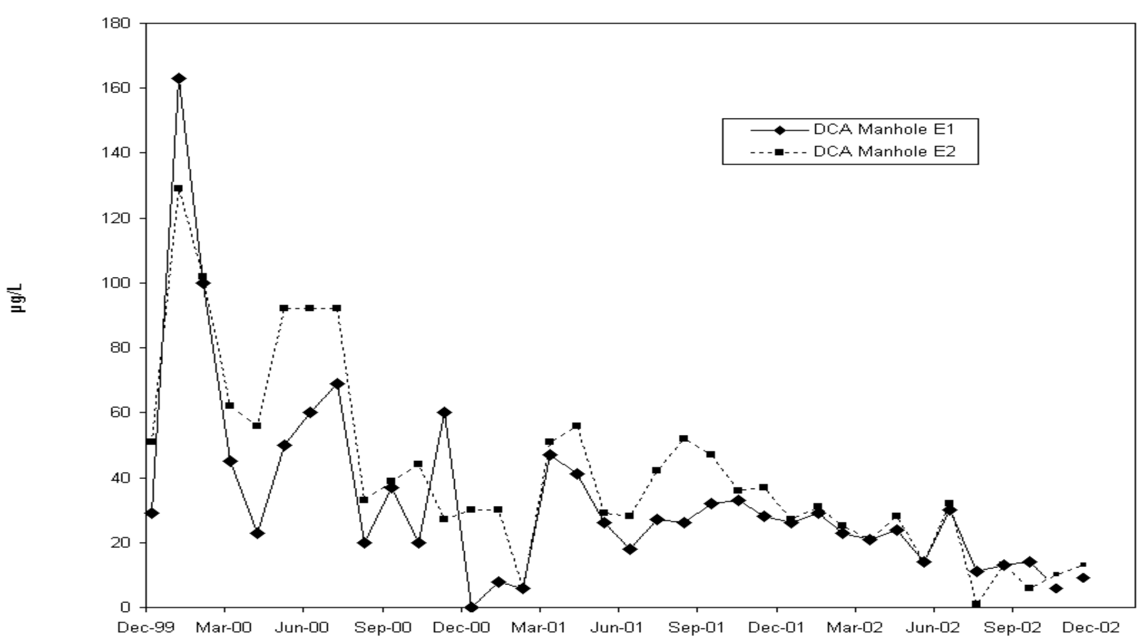


Figure 6.11 Manholes E1 and E2 1,1-Dichloroethane Levels, 2000 to 2002

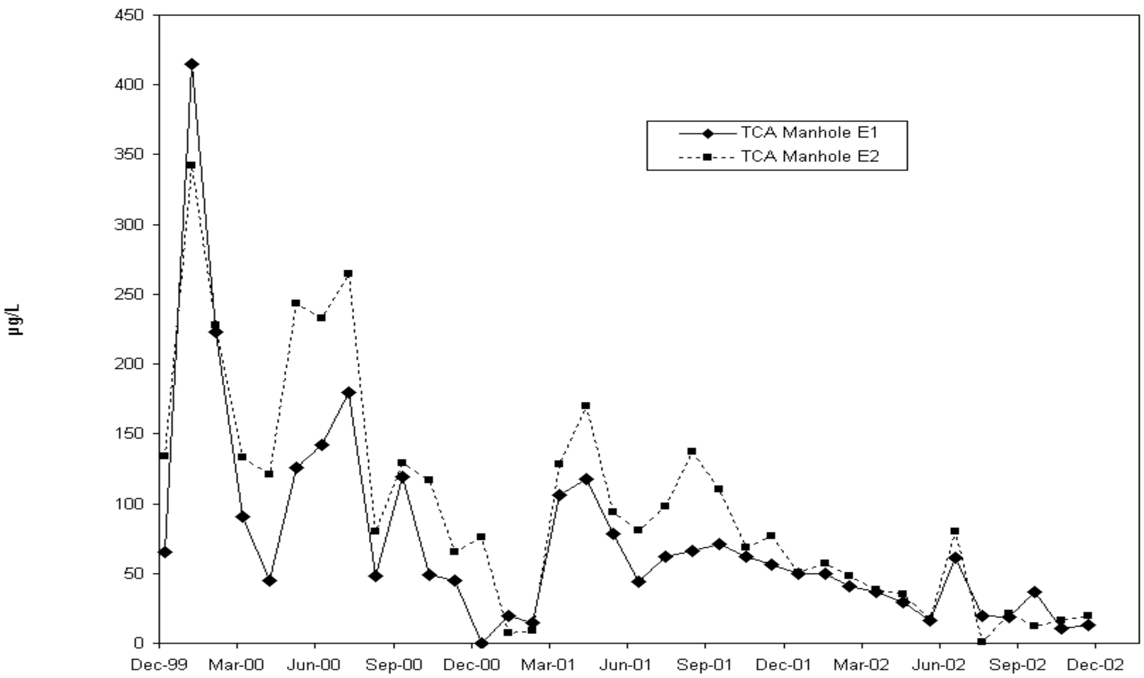


Figure 6.12 Manholes E1 and E2 1,1,1-Trichloroethane Levels, 2000 to 2002

Water from the 317 Area and 319 Area groundwater collection systems is pumped to Manhole 2E. Manhole 1E is connected to the footing drain system around the operating vaults. In addition to VOCs, the manhole water is analyzed for hydrogen-3 and gamma-ray–emitting radionuclides. Table 6.18 gives the hydrogen-3 results. Although the hydrogen-3 concentrations are relatively high, the volume is fairly low. Because hydrogen-3 concentrations are generally higher in Manhole 2E, the source of the hydrogen-3 appears to be from the 319 Area groundwater pumping system. The sharp increase in hydrogen-3 concentrations from September 2002 to the end of the year is most likely due to lack of dilution resulting from drought conditions. As previously mentioned, the period of September through December 2002 was the third driest since official rainfall records began here in 1871. No gamma-ray–emitting radionuclides were detected in any samples.

6.3. Sanitary Landfill

The 800 Area is the site of the ANL-E sanitary landfill. The 8.8-ha (21.8-acre) landfill is located on the western edge of ANL-E property (Figure 1.1). The landfill received waste from 1966 until September 1992 and was operated under IEPA Permit No. 1981-29-OP, which was issued on September 18, 1981. The landfill received general refuse, construction debris, boiler house ash, and other nonradioactive solid waste. The landfill is now being closed pursuant to Permit No. 1992-002-SP and Supplemental Permit Nos. 1994-506-SP, 1997-295-SP, 1998-017-SP, 1999-107-SP, 1999-476-SP, and 2002-194-SP. Beginning in early 2003 postclosure care of the 800 Area Landfill will be carried out under the corrective action provisions (Section V) of ANL-E's RCRA Part B Permit.

TABLE 6.18

Hydrogen-3 Concentrations in Manhole Water Samples, 2002
(concentrations in pCi/L)

Date Collected	Manhole 1E	Manhole 2E
01/15/02	1,273	1,165
02/11/02	1,467	1,454
03/12/02	318	374
04/04/02	966	924
05/14/02	875	985
06/12/02	824	761
07/18/02	881	789
08/05/02	3,468	155
09/10/02	1,656	1,742
10/09/02	2,423	24,030
11/13/02	2,898	14,980
12/08/02	8,690	26,340

6.3.1. French Drain

The landfill area was used for the disposal of certain types of liquid wastes from 1969 to 1978. The wastes were poured into a French drain that consisted of a corrugated steel pipe placed in a gravel-filled pit dug into an area previously filled with waste. The liquid waste was poured into the drain and allowed to permeate into the gravel, and thence into the soil and fill material. Available documentation indicates that 109,000 L (29,000 gal) of liquid waste was placed in this drain. Most of this material was used oil or used machining coolant (oil water emulsion). Some of the wastes disposed of in this manner would currently be defined as hazardous wastes. The presence of volatile and other toxic organic compounds has been confirmed by extensive characterization activities conducted at the landfill. Measurable amounts of these materials were identified in leachate but not in groundwater near the landfill.

6.3.2. Monitoring Studies

During October 1992, 15 stainless-steel wells, 800161 through 800203D, were installed around the landfill as part of the IEPA-approved closure plan. Wells 800172 and 800182 are consistently dry. The 13 active wells are required to be monitored as part of the IEPA-approved groundwater monitoring program, effective January 1995. These wells are set in five clusters; each cluster consists of a shallow, medium, and deep well (see Figure 6.13 and Table 6.19).

In late spring of 1999, an environmental remediation project was completed that resulted in the extension of the landfill cap in the north portion of the landfill to cover some recently identified waste material. As part of this project, the landfill cap, perimeter road and fence were moved 15 m (50 ft) north, and monitoring wells 800161, 800162, and 800163D were replaced. The sampling of the replacement wells — 800381, 800382, and 800383D — commenced in July 1999.

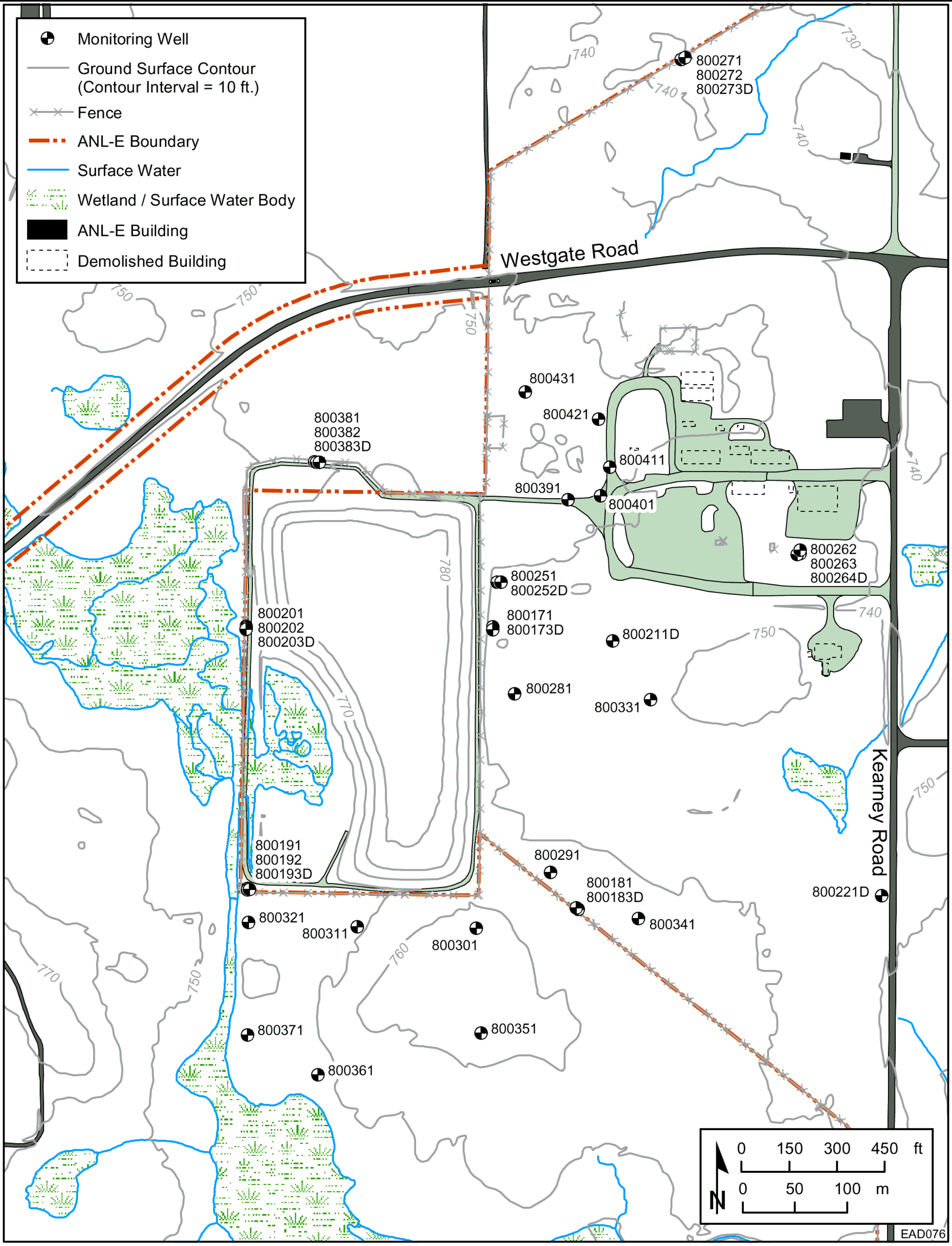


Figure 6.13 Active Monitoring Wells in the 800 Area Landfill

TABLE 6.19

Groundwater Monitoring Wells: 800 Area Landfill

ID Number[a]	Well Depth (m bgs)	Ground Elevation (m AMSL)	Monitoring Zone (m AMSL)	Well Type[b]	Date Drilled
800171	7.62	228.11	222.32–220.80	0.05/SS	10/92
800173D	39.62	228.41	192.13–189.09	0.05/SS	10/92
800181	10.67	230.52	221.37–219.85	0.05/SS	10/92
800183D	49.99	230.37	183.43–180.38	0.05/SS	10/92
800191	4.63	227.38	224.43–222.90	0.05/SS	10/92
800192	18.29	227.40	210.63–209.11	0.05/SS	10/92
800193D	46.02	227.37	184.40–181.35	0.05/SS	10/92
800201	10.67	227.93	218.78–217.26	0.05/SS	10/92
800202	18.38	227.92	211.07–209.54	0.05/SS	10/92
800203D	38.40	227.92	192.63–189.59	0.05/SS	9/92
800271	4.57	223.18	223.18–221.65	0.05/SS	8/99
800272	13.72	225.61	213.42–211.90	0.05/SS	8/99
800273D	37.49	225.61	191.78–188.73	0.05/SS	8/99
800281	3.96	227.65	225.52–224.00	0.05/SS	9/99
800291	7.01	230.49	225.00–223.48	0.05/SS	9/99
800301	7.62	232.53	226.51–224.99	0.05/SS	9/99
800311	13.72	227.41	217.35–214.31	0.05/SS	9/99
800321	4.27	227.93	225.26–223.66	0.05/SS	9/99
800331	5.18	227.93	224.27–222.75	0.05/SS	9/99
800341	3.96	229.97	227.53–226.01	0.05/SS	9/99
800351	11.89	232.75	223.91–220.86	0.05/SS	9/99
800361	7.01	227.53	222.12–220.60	0.05/SS	9/99
800371	9.75	227.50	219.27–217.83	0.05/SS	9/99
800381[c]	7.31	231.11	227.44–224.40	0.05/SS	6/99
800382[c]	19.20	231.18	215.33–212.28	0.05/SS	6/99
800383D[c]	44.50	231.24	190.39–187.35	0.05/SS	6/99

[a] Wells identified by a "D" are deeper wells monitoring the dolomite bedrock aquifer.

[b] Inner diameter (m)/well material (SS = stainless steel).

[c] Replacement wells used after July 1, 1999.

IEPA Supplemental Permit No. 1999-107-SP, effective June 16, 1999, provided for (1) the installation and addition of three new upgradient groundwater monitoring wells, 800271, 800272, and 800273D; and (2) the addition of 10 new downgradient groundwater monitoring wells (800281, 800291, 800301, 800311, 800321, 800331, 800341, 800351, 800361, and 800371). Sampling of these wells commenced in October 1999. Table 6.19 provides information on these wells, and Figure 6.13 shows their locations. Wells 800272 and 800311 have been dry since installation. Well 800321 was dry the third and fourth quarters.

6.3.2.1. Sample Collection

The same procedure for well water sample collection previously described for the 300 Area was used for this area. Each well is sampled annually for semivolatiles, PCBs, pesticides, and herbicides. Also, during the second quarter, in accordance with the IEPA-approved groundwater monitoring plan, both filtered and unfiltered samples for numerous parameters (e.g., metals, chloride, sulfate) are required. Volatile organics are monitored each quarter, although only required by permit during the second quarter.

6.3.2.2. Sample Analyses - 800 Area

The 800 Area sample analyses were performed using SOPs written, reviewed, and issued as controlled documents by members of CMT/ESH-AC. These SOPs reference protocols in SW-846.[6] Fifteen metals were routinely determined and analyzed by using inductively coupled plasma atomic emission spectroscopy and graphite furnace atomic absorption spectroscopy. Mercury was determined by cold vapor atomic absorption spectroscopy. VOCs were determined by using a purge and trap sample pretreatment, followed by gas chromatography-mass spectroscopy detection. SVOCs were determined by solvent extraction followed by gas chromatography-mass spectroscopy detection. PCBs and pesticides were determined by solvent extraction followed by gas chromatography-electron capture detection. TDS were determined gravimetrically. Sulfate determination was performed by using a turbidimetric technique, while chloride was determined by titrimetry. Ammonia nitrogen was determined by using distillation followed by an ion-selective electrode technique.

Some analyses were performed at an off-site contractor laboratory. SW-846[6] procedures were specified and used. Cyanide and phenol were determined by distillation followed by a spectrophotometric measurement. Total organic carbon (TOC) and total organic halogen (TOX) were determined by combustion techniques followed by infrared detection and coulometric titration, respectively. Chlorinated organic compounds and carbamate pesticides were analyzed by extractions followed by gas and liquid chromatography techniques, respectively.

The 800 Area groundwater radiological analyses were performed using SOPs written, reviewed, and issued as controlled documents by members of CMT/ESH-AC. Hydrogen-3 was determined by distillation followed by a beta liquid scintillation counting technique. Cesium-137 was determined by gamma-ray spectrometry.

6.3.2.3. Results of Analyses

Descriptions of each well, field parameters measured during sample collection, and the results of chemical and radiological analysis of samples from the wells in the 800 Area are presented in Tables 6.20 to 6.43. All radiological and inorganic analysis results are shown in these tables. The analytical methods used for organic compounds could identify and quantify all the compounds contained in the CLP Target Compound List. However, the vast majority of these compounds were not detected in the samples. Only those constituents that were present in amounts great enough to quantify are shown. The detection limits for the organic compounds listed were typically 1 to 10 μg/L. Figures 6.14 to 6.24 show the trends for exceedances of the WQS for wells monitored as part of the IEPA-approved groundwater monitoring program for the sanitary landfill. Results represent filtered samples only because filtered samples were collected each quarter for the constituents presented.

ANL-E chose a conservative approach for evaluating the inorganic monitoring results by selecting as the standard of comparison the Illinois Groundwater Quality Standards for Class I: Potable Resource Groundwater, 35 IAC Part 620.410. The most common constituents at levels above the WQS (see Table 6.15) are chloride, iron, TDS, unfiltered lead, and manganese. This is consistent with results reported in prior years using the pre-IEPA–approved routine well monitoring network. In general, data for the shallow wells indicate exceedances of the manganese, TDS, and sulfate WQSs in a number of wells. These results are consistent with results reported in prior years. Chloride exceedances are infrequent and were noted only one quarter in a shallow well. Chromium and nickel WQSs were exceeded in two shallow wells. The intermediate wells have fewer exceedances except for iron and manganese. Iron exceeded the WQS in all three intermediate wells, and manganese exceeded the WQS in two wells. TDS and lead (unfiltered) were exceeded only one quarter in one intermediate well. The results for the deep wells show no exceedances except for chloride three quarters in Well 800173D.

Field Parameters. Field parameters include such items as well and water depth information, pH, specific conductance, and temperature of water. These parameters are measured each quarter. No standards exist for comparative purposes, with the exception of pH. However, results are consistent from quarter to quarter and are similar to results obtained in previous years.

Filtered Routine Indicator Parameters. Filtered routine indicator parameters include ammonia nitrogen, arsenic, cadmium, chloride, iron, lead, manganese, mercury, sulfate, and TDS.

TABLE 6.20

Groundwater Monitoring Results, Sanitary Landfill Well 800381, 2002

		Date of Sampling			
Parameter	Unit	01/14/02	04/09/02	07/10/02	10/07/02
Water elevation[a]	m	227.86	230.04	227.73	226.71
Temperature	°C	11.4	9.3	12.4	11.9
pH	pH	7.02	6.95	6.86	6.87
Redox	mV	7	14	8	-18
Conductivity	µmhos/cm	1,752	1,409	1,540	1,631
Chloride[b]	mg/L	54	42	45	42
Sulfate[b]	mg/L	398	351	**403**[d]	**481**
TDS[b]	mg/L	1,152	1,102	**1,235**	**1,217**
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[e]	0.0118	-	-
Barium[c]	mg/L	-	0.0805	-	-
Boron[c]	mg/L	-	0.1178	-	-
Cadmium[c]	mg/L	-	0.0003	-	-
Chromium[c]	mg/L	-	< 0.0240	-	-
Cobalt[c]	mg/L	-	< 0.0160	-	-
Copper[c]	mg/L	-	0.0179	-	-
Iron[c]	mg/L	-	**15.64**	-	-
Lead[c]	mg/L	-	**0.0122**	-	-
Manganese[c]	mg/L	-	**0.6227**	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-
Nickel[c]	mg/L	-	0.0218	-	-
Selenium[c]	mg/L	-	< 0.003	-	-
Silver[c]	mg/L	-	0.0013	-	-
Zinc[c]	mg/L	-	0.067	-	-
Ammonia nitrogen[b]	mg/L	< 0.10	0.22	0.09	0.14
Arsenic[b]	mg/L	0.0144	0.0045	0.0036	0.0051
Barium[b]	mg/L	0.0351	0.0563	0.0471	0.0494
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	1.1590	0.6237	0.4951	0.4160
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	**0.8868**	**0.4921**	**0.7198**	**0.2085**
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.020	0.070	0.008	0.011
Nitrate[c]	mg/L	-	< 0.1	-	-
Phenols[c]	mg/L	< 0.0050	0.0091	< 0.0050	< 0.0050
Cesium-137[c]	pCi/L	-	< 2.0	-	-
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	-	45	-	-
Fluoride[c]	mg/L	-	0.171	-	-
Sulfate[c]	mg/L	-	362	-	-
TOCs[c]	mg/L	3.5	3.3	3.2	3.3
TOCs[c]	mg/L	3.5	3.1	3.3	3.4
TOCs[c]	mg/L	3.5	3.2	3.2	3.3
TOCs[c]	mg/L	3.5	3.1	3.3	3.3
TOXs[c]	mg/L	0.025	0.032	0.049	0.026
TOXs[c]	mg/L	0.024	0.039	0.034	0.031

[a] Well point elevation = 224.40 m (MSL); ground surface elevation = 231.11 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

[e] A hyphen indicates that no samples were collected.

TABLE 6.21

Groundwater Monitoring Results, Sanitary Landfill Well 800382, 2002

		Date of Sampling			
Parameter	Unit	1/14/02	04/09/02	07/08/02	10/07/02
Water elevation[a]	m	219.34	219.50	219.76	219.09
Temperature	°C	10.5	12.7	17.3	11.2
pH	pH	7.26	7.14	7.18	7.05
Redox	mV	-7	1	-22	-29
Conductivity	µmhos/cm	1,086	957	960	1,049
Chloride[b]	mg/L	94	99	92	96
Sulfate[b]	mg/L	46	74	68	61
TDS[b]	mg/L	622	718	697	722
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	0.0088	-	-
Barium[c]	mg/L	-	0.1795	-	-
Boron[c]	mg/L	-	0.1884	-	-
Cadmium[c]	mg/L	-	0.0004	-	-
Chromium[c]	mg/L	-	0.0345	-	-
Cobalt[c]	mg/L	-	0.0215	-	-
Copper[c]	mg/L	-	0.0413	-	-
Iron[c]	mg/L	-	**47.98**[e]	-	-
Lead[c]	mg/L	-	**0.0361**	-	-
Manganese[c]	mg/L	-	**0.8550**	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-
Nickel[c]	mg/L	-	0.0497	-	-
Selenium[c]	mg/L	-	< 0.0030	-	-
Silver[c]	mg/L	-	0.0014	-	-
Zinc[c]	mg/L	-	0.116	-	-
Ammonia nitrogen[b]	mg/L	0.50	0.34	0.18	0.19
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.1183	0.1115	0.1228	0.1238
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.9712	2.1860	0.1047	< 0.0200
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.1032	0.1020	0.1109	0.1207
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Nitrate[c]	mg/L	-	< 0.1	-	-
Phenols[c]	mg/L	< 0.005	< 0.005	0.021	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	-	99	-	-
Fluoride[c]	mg/L	-	0.218	-	-
Sulfate[c]	mg/L	-	72	-	-
TOCs[c]	mg/L	2.7	2.6	2.4	3.0
TOCs[c]	mg/L	2.7	2.6	2.4	3.0
TOCs[c]	mg/L	2.6	2.6	2.4	3.1
TOCs[c]	mg/L	2.6	2.6	2.4	3.0
TOXs[c]	mg/L	0.018	0.045	0.037	0.047
TOXs[c]	mg/L	0.051	0.040	0.024	0.038

[a] Well point elevation = 212.28 m (MSL); ground surface elevation = 231.18 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

[e] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.22

Groundwater Monitoring Results, Sanitary Landfill Well 800383D, 2002

		Date of Sampling			
Parameter	Unit	01/14/02	04/09/02	07/08/02	10/07/02
Water elevation[a]	m	193.18	193.00	193.12	192.84
Temperature	°C	10.6	11.9	10.8	11.7
pH	pH	7.17	7.03	6.98	6.84
Redox	mV	-2	7	-8	-17
Conductivity	µmhos/cm	1,358	1,206	1,210	1,306
Chloride[b]	mg/L	136	142	171	141
Sulfate[b]	mg/L	169	139	171	117
TDS[b]	mg/L	808	922	904	871
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	< 0.003	-	-
Barium[c]	mg/L	-	0.0642	-	-
Boron[c]	mg/L	-	0.1801	-	-
Cadmium[c]	mg/L	-	< 0.0002	-	-
Chromium[c]	mg/L	-	< 0.024	-	-
Cobalt[c]	mg/L	-	< 0.016	-	-
Copper[c]	mg/L	-	< 0.015	-	-
Iron[c]	mg/L	-	2.202	-	-
Lead[c]	mg/L	-	< 0.002	-	-
Manganese[c]	mg/L	-	0.0653	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-
Nickel[c]	mg/L	-	< 0.02	-	-
Selenium[c]	mg/L	-	< 0.003	-	-
Silver[c]	mg/L	-	0.0021	-	-
Zinc[c]	mg/L	-	< 0.008	-	-
Ammonia nitrogen[b]	mg/L	0.80	0.69	0.45	0.41
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0698	0.0713	0.0725	0.0702
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.8863	1.3160	1.2600	1.2380
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0491	0.0517	0.0515	0.0472
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Nitrate[c]	mg/L	-	< 0.1	-	-
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	-	145	-	-
Fluoride[c]	mg/L	-	0.32	-	-
Sulfate[c]	mg/L	-	193	-	-
TOCs[c]	mg/L	1.5	1.4	1.4	1.7
TOCs[c]	mg/L	1.5	1.4	1.5	1.6
TOCs[c]	mg/L	1.6	1.4	1.4	1.6
TOCs[c]	mg/L	1.4	1.4	1.4	1.6
TOXs[c]	mg/L	0.011	0.036	0.029	0.033
TOXs[c]	mg/L	0.018	0.052	0.047	0.076

[a] Well point elevation = 187.35 m (MSL); ground surface elevation = 231.24 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

TABLE 6.23

Groundwater Monitoring Results, Sanitary Landfill Well 800171, 2002

Parameter	Unit	Date of Sampling 01/23/02	04/09/02	07/16/02	07/16/02	10/07/02
Water elevation[a]	m	226.05	227.46	225.63	225.63	225.23
Temperature	°C	11.9	10.3	11.7	11.7	11.9
pH	pH	6.75	6.91	6.71	6.71	6.63
Redox	mV	25	15	-	-	-5
Conductivity	µmhos/cm	1,110	922	1,113	1,113	1,217
Chloride[b]	mg/L	14	12	13	13	13
Sulfate[b]	mg/L	116	116	125	112	116
TDS[b]	mg/L	746	622	755	783	768
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	0.0037	-	-	-
Barium[c]	mg/L	-	0.1155	-	-	-
Boron[c]	mg/L	-	0.2818	-	-	-
Cadmium[c]	mg/L	-	0.0002	-	-	-
Chromium[c]	mg/L	-	0.0324	-	-	-
Cobalt[c]	mg/L	-	< 0.016	-	-	-
Copper[c]	mg/L	-	< 0.015	-	-	-
Iron[c]	mg/L	-	**17.12**[e]	-	-	-
Lead[c]	mg/L	-	**0.0118**	-	-	-
Manganese[c]	mg/L	-	**1.383**	-	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-	-
Nickel[c]	mg/L	-	0.0244	-	-	-
Selenium[c]	mg/L	-	< 0.003	-	-	-
Silver[c]	mg/L	-	< 0.001	-	-	-
Zinc[c]	mg/L	-	0.057	-	-	-
Ammonia nitrogen[b]	mg/L	< 0.10	0.29	0.18	0.03	0.19
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0590	0.0501	0.0661	0.0652	0.0633
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.0526	< 0.0200	0.0222	0.0217	< 0.0200
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	**0.2286**	0.1484	**0.2777**	**0.2416**	**0.2298**
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008
Nitrate[c]	mg/L	-	0.18	-	-	-
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	0.023	< 0.005
Cesium-137[c]	pCi/L	-	< 2.0	-	-	-
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	-	12	-	-	-
Fluoride[c]	mg/L	-	0.404	-	-	-
Sulfate[c]	mg/L	-	114	-	-	-
TOCs[c]	mg/L	2.5	2.6	2.5	2.4	2.4
TOCs[c]	mg/L	2.4	2.7	2.6	2.5	2.4
TOCs[c]	mg/L	2.6	2.6	2.5	2.4	2.4
TOCs[c]	mg/L	2.5	2.6	2.6	2.5	2.4
TOXs[c]	mg/L	0.023	0.038	0.036	0.033	0.025
TOXs[c]	mg/L	0.023	0.030	0.034	0.039	0.066

[a] Well point elevation = 220.80 m (MSL); ground surface elevation = 228.11 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

[e] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.24

Groundwater Monitoring Results, Sanitary Landfill Well 800173D, 2002

Parameter	Unit	Date of Sampling 01/23/02	01/23/02	04/09/02	07/17/02	10/07/02
Water elevation[a]	m	192.31	192.31	192.28	192.37	192.09
Temperature	°C	11.4	11.4	11.3	15.1	11.4
pH	pH	6.88	6.88	6.91	6.77	6.73
Redox	mV	17	17	15	-1	-12
Conductivity	µmhos/cm	1,314	1,314	1,325	1,152	1,521
Chloride[b]	mg/L	190	185	**202**[d]	**213**	**261**
Sulfate[b]	mg/L	137	128	99	148	92
TDS[b]	mg/L	845	849	934	961	928
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	**0.28**
Arsenic[c]	mg/L	-[e]	-	0.004	-	-
Barium[c]	mg/L	-	-	0.0847	-	-
Boron[c]	mg/L	-	-	0.1822	-	-
Cadmium[c]	mg/L	-	-	< 0.0002	-	-
Chromium[c]	mg/L	-	-	< 0.024	-	-
Cobalt[c]	mg/L	-	-	< 0.016	-	-
Copper[c]	mg/L	-	-	< 0.015	-	-
Iron[c]	mg/L	-	-	3.088	-	-
Lead[c]	mg/L	-	-	< 0.002	-	-
Manganese[c]	mg/L	-	-	0.0661	-	-
Mercury[c]	mg/L	-	-	< 0.0001	-	-
Nickel[c]	mg/L	-	-	< 0.02	-	-
Selenium[c]	mg/L	-	-	< 0.003	-	-
Silver[c]	mg/L	-	-	< 0.001	-	-
Zinc[c]	mg/L	-	-	< 0.008	-	-
Ammonia nitrogen[b]	mg/L	0.81	0.40	0.74	0.27	0.36
Arsenic[b]	mg/L	0.0051	0.0036	0.0034	0.0037	0.0047
Barium[b]	mg/L	0.0822	0.0788	0.0810	0.0811	0.0867
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	2.105	2.046	1.295	1.729	1.639
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0619	0.0607	0.0622	0.0684	0.0648
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008
Nitrate[c]	mg/L	-	-	< 0.1	-	-
Phenols[c]	mg/L	0.01	< 0.005	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100	396
Chloride[c]	mg/L	-	-	197	-	-
Fluoride[c]	mg/L	-	-	0.354	-	-
Sulfate[c]	mg/L	-	-	105	-	-
TOCs[c]	mg/L	3.7	3.5	3.6	3.9	5.5
TOCs[c]	mg/L	3.7	3.5	3.7	4.0	5.6
TOCs[c]	mg/L	3.7	3.6	3.6	3.8	5.6
TOCs[c]	mg/L	3.7	3.6	3.7	3.8	5.6
TOXs[c]	mg/L	0.031	0.020	0.039	0.020	0.080
TOXs[c]	mg/L	0.039	0.045	0.043	0.070	0.160

[a] Well point elevation = 189.09 m (MSL); ground surface elevation = 228.41 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

[e] A hyphen indicates that no samples were collected.

TABLE 6.25

Groundwater Monitoring Results, Sanitary Landfill Well 800181, 2002

		Date of Sampling		
Parameter	Unit	01/23/02	04/23/02	07/17/02
Water elevation[a]	m	223.43	226.99	222.69
Temperature	°C	10.2	10.3	7.3
pH	pH	7.46	7.88	7.40
Redox	mV	-17	-43	-37
Conductivity	μmhos/cm	1,080	825	861
Chloride[b]	mg/L	13	8	6
Sulfate[b]	mg/L	212	175	101
TDS[b]	mg/L	751	556	589
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	0.0092	-
Barium[c]	mg/L	-	0.1885	-
Boron[c]	mg/L	-	0.1260	-
Cadmium[c]	mg/L	-	0.0002	-
Chromium[c]	mg/L	-	0.0473	-
Cobalt[c]	mg/L	-	0.0165	-
Copper[c]	mg/L	-	0.0297	-
Iron[c]	mg/L	-	**35.24**[e]	-
Lead[c]	mg/L	-	**0.0181**	-
Manganese[c]	mg/L	-	**0.7269**	-
Mercury[c]	mg/L	-	< 0.0001	-
Nickel[c]	mg/L	-	0.0419	-
Selenium[c]	mg/L	-	< 0.0030	-
Silver[c]	mg/L	-	0.0013	-
Zinc[c]	mg/L	-	0.094	-
Ammonia nitrogen[b]	mg/L	< 0.10	0.11	0.08
Arsenic[b]	mg/L	< 0.0030	0.0047	0.0053
Barium[b]	mg/L	0.0349	0.0202	0.0265
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	0.0342	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	< 0.01	< 0.01	< 0.01
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008
Nitrate[c]	mg/L	-	< 0.1	-
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100
Chloride[c]	mg/L	-	8	-
Fluoride[c]	mg/L	-	0.208	-
Sulfate[c]	mg/L	-	171	-
TOCs[c]	mg/L	1.9	2.3	2.1
TOCs[c]	mg/L	1.8	2.1	2.0
TOCs[c]	mg/L	1.8	2.2	2.0
TOCs[c]	mg/L	1.8	2.2	2.0
TOXs[c]	mg/L	0.010	0.022	0.280
TOXs[c]	mg/L	0.012	0.027	0.340

[a] Well point elevation = 219.85 m (MSL); ground surface elevation = 230.52 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

[e] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.26

Groundwater Monitoring Results, Sanitary Landfill Well 800183D, 2002

		Date of Sampling			
Parameter	Unit	01/23/02	04/24/02	07/17/02	10/15/02
Water elevation[a]	m	192.33	192.46	192.43	192.22
Temperature	°C	10.3	12.4	9.5	11.6
pH	pH	7.39	6.96	7.14	7.08
Redox	mV	-9	6	-22	-30
Conductivity	µmhos/cm	1,117	1,174	1,169	1,275
Chloride[b]	mg/L	125	126	112	123
Sulfate[b]	mg/L	151	198	163	120
TDS[b]	mg/L	778	814	901	818
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	< 0.003	-	-
Barium[c]	mg/L	-	0.0464	-	-
Boron[c]	mg/L	-	0.1947	-	-
Cadmium[c]	mg/L	-	< 0.0002	-	-
Chromium[c]	mg/L	-	< 0.024	-	-
Cobalt[c]	mg/L	-	< 0.016	-	-
Copper[c]	mg/L	-	< 0.015	-	-
Iron[c]	mg/L	-	0.7464	-	-
Lead[c]	mg/L	-	< 0.002	-	-
Manganese[c]	mg/L	-	0.0152	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-
Nickel[c]	mg/L	-	< 0.02	-	-
Selenium[c]	mg/L	-	< 0.003	-	-
Silver[c]	mg/L	-	< 0.001	-	-
Zinc[c]	mg/L	-	< 0.008	-	-
Ammonia nitrogen[b]	mg/L	0.89	0.89	0.47	0.26
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0478	0.0451	0.0465	0.0506
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.5514	0.4124	0.6743	0.5778
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0144	0.0164	0.0151	0.0157
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Nitrate[c]	mg/L	-	< 0.1	-	-
Phenols[c]	mg/L	< 0.005	0.0056	< 0.005	0.017
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	-	124	-	-
Fluoride[c]	mg/L	-	0.322	-	-
Sulfate[c]	mg/L	-	209	-	-
TOCs[c]	mg/L	2.2	2.3	2.3	2.4
TOCs[c]	mg/L	2.2	2.4	2.1	2.4
TOCs[c]	mg/L	2.3	2.4	2.1	2.4
TOCs[c]	mg/L	2.2	2.4	2.1	2.4
TOXs[c]	mg/L	0.022	0.028	0.022	0.048
TOXs[c]	mg/L	0.020	0.062	0.042	0.031

[a] Well point elevation = 180.38 m (MSL); ground surface elevation = 230.37 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

TABLE 6.27

Groundwater Monitoring Results, Sanitary Landfill Well 800191, 2002

		Date of Sampling			
Parameter	Unit	01/08/02	04/10/02	07/10/02	10/08/02
Water elevation[a]	m	225.34	225.96	225.28	225.18
Temperature	°C	10.5	8.8	11.6	13.5
pH	pH	6.90	6.73	6.79	6.81
Redox	mV	15	25	3	-15
Conductivity	µmhos/cm	1,893	1,851	1,685	1,711
Chloride[b]	mg/L	194	128	101	**269**[d]
Sulfate[b]	mg/L	349	206	372	212
TDS[b]	mg/L	**1,245**	**1,590**	**1,430**	1,044
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[e]	0.0036	-	-
Barium[c]	mg/L	-	0.2125	-	-
Boron[c]	mg/L	-	0.1668	-	-
Cadmium[c]	mg/L	-	0.0005	-	-
Chromium[c]	mg/L	-	< 0.024	-	-
Cobalt[c]	mg/L	-	< 0.016	-	-
Copper[c]	mg/L	-	0.0331	-	-
Iron[c]	mg/L	-	**39.16**	-	-
Lead[c]	mg/L	-	**0.0218**	-	-
Manganese[c]	mg/L	-	**2.186**	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-
Nickel[c]	mg/L	-	0.021	-	-
Selenium[c]	mg/L	-	< 0.003	-	-
Silver[c]	mg/L	-	< 0.001	-	-
Zinc[c]	mg/L	-	0.082	-	-
Ammonia nitrogen[b]	mg/L	0.5	0.72	0.48	0.29
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0689	0.0744	0.0611	0.0679
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	1.253	**7.012**	4.316	1.890
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	**1.662**	**1.880**	**1.480**	**1.353**
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.017	< 0.008	0.009	0.018
Nitrate[c]	mg/L	-	< 0.1	-	-
Phenols[c]	mg/L	< 0.005	< 0.005	0.0084	0.0057
Cesium-137[c]	pCi/L	-	< 2.0	-	-
Hydrogen-3[c]	pCi/L	108	< 100	< 100	< 100
Chloride[c]	mg/L	-	141	-	-
Fluoride[c]	mg/L	-	0.199	-	-
Sulfate[c]	mg/L	-	213	-	-
TOCs[c]	mg/L	5.4	8.6	6.0	6.5
TOCs[c]	mg/L	5.5	8.7	6.0	6.6
TOCs[c]	mg/L	5.5	8.8	6.1	6.7
TOCs[c]	mg/L	5.4	8.6	6.1	6.6
TOXs[c]	mg/L	0.037	0.058	0.024	0.055
TOXs[c]	mg/L	0.044	0.050	0.041	0.110

[a] Well point elevation = 222.90 m (MSL); ground surface elevation = 227.38 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

[e] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.28

Groundwater Monitoring Results, Sanitary Landfill Well 800192, 2002

Parameter	Unit	Date of Sampling 01/08/02	04/10/02	07/10/02	10/08/02	10/08/02
Water elevation[a]	m	219.55	220.91	218.42	217.67	217.67
Temperature	°C	8.9	13.1	12.6	12.3	12.3
pH	pH	7.02	7.24	6.77	6.72	6.72
Redox	mV	9	-4	4	-8	-8
Conductivity	µmhos/cm	1,615	1,299	1,357	1,506	1,506
Chloride[b]	mg/L	92	90	62	81	85
Sulfate[b]	mg/L	301	202	341	321	322
TDS[b]	mg/L	1,092	1,170	**1,210**[d]	1,112	1,115
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[e]	0.0031	-	-	-
Barium[c]	mg/L	-	0.5543	-	-	-
Boron[c]	mg/L	-	0.091	-	-	-
Cadmium[c]	mg/L	-	< 0.0002	-	-	-
Chromium[c]	mg/L	-	< 0.024	-	-	-
Cobalt[c]	mg/L	-	< 0.016	-	-	-
Copper[c]	mg/L	-	< 0.015	-	-	-
Iron[c]	mg/L	-	**18.08**	-	-	-
Lead[c]	mg/L	-	< 0.002	-	-	-
Manganese[c]	mg/L	-	**0.1848**	-	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-	-
Nickel[c]	mg/L	-	< 0.02	-	-	-
Selenium[c]	mg/L	-	< 0.003	-	-	-
Silver[c]	mg/L	-	< 0.001	-	-	-
Zinc[c]	mg/L	-	< 0.008	-	-	-
Ammonia nitrogen[b]	mg/L	0.70	1.30	0.54	0.46	0.59
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.4701	0.4626	0.4085	0.4439	0.4147
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	**10.8500**	**11.3200**	1.0370	0.1765	0.1068
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	**0.1626**	**0.2000**	**0.1531**	**0.1885**	**0.1815**
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.0200	0.0474	< 0.0200	< 0.0200	< 0.0200
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008
Nitrate[c]	mg/L	-	< 0.1	-	-	-
Phenols[c]	mg/L	< 0.0050	0.0054	< 0.0050	< 0.0050	< 0.0050
Cesium-137[c]	pCi/L	-	< 2	-	-	-
Hydrogen-3[c]	pCi/L	435	427	462	< 100	396
Chloride[c]	mg/L	-	92	-	-	-
Fluoride[c]	mg/L	-	0.21	-	-	-
Sulfate[c]	mg/L	-	209	-	-	-
TOCs[c]	mg/L	11.0	14.0	6.6	14.0	12.0
TOCs[c]	mg/L	11.0	15.0	6.7	14.0	12.0
TOCs[c]	mg/L	11.0	15.0	6.7	14.0	12.0
TOCs[c]	mg/L	11.0	14.0	6.6	14.0	12.0
TOXs[c]	mg/L	0.062	0.059	0.025	0.045	0.097
TOXs[c]	mg/L	0.043	0.038	0.034	0.045	0.063

[a] Well point elevation = 209.11 m (MSL); ground surface elevation = 227.40 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

[e] A hyphen indicates that no samples were collected.

TABLE 6.29

Groundwater Monitoring Results, Sanitary Landfill Well 800193D, 2002

		Date of Sampling			
Parameter	Unit	01/08/02	04/10/02	07/10/02	10/08/02
Water elevation[a]	m	192.38	192.22	192.34	192.14
Temperature	°C	10.9	6.9	13.0	11.5
pH	pH	7.29	7.22	6.96	6.91
Redox	mV	1	-3	-7	-21
Conductivity	µmhos/cm	1,395	1,206	1,214	1,329
Chloride[b]	mg/L	137	126	139	117
Sulfate[b]	mg/L	151	194	155	133
TDS[b]	mg/L	884	942	974	889
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	< 0.003	-	-
Barium[c]	mg/L	-	0.0591	-	-
Boron[c]	mg/L	-	0.2255	-	-
Cadmium[c]	mg/L	-	< 0.0002	-	-
Chromium[c]	mg/L	-	< 0.024	-	-
Cobalt[c]	mg/L	-	< 0.016	-	-
Copper[c]	mg/L	-	< 0.015	-	-
Iron[c]	mg/L	-	1.56	-	-
Lead[c]	mg/L	-	< 0.002	-	-
Manganese[c]	mg/L	-	0.0248	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-
Nickel[c]	mg/L	-	< 0.02	-	-
Selenium[c]	mg/L	-	< 0.003	-	-
Silver[c]	mg/L	-	< 0.001	-	-
Zinc[c]	mg/L	-	< 0.008	-	-
Ammonia nitrogen[b]	mg/L	0.80	-	0.75	0.52
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0600	0.0608	0.0598	0.0630
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	1.1900	0.9783	0.7042	1.1020
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0212	0.0241	0.0217	0.0252
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Nitrate[c]	mg/L	-	< 0.1	-	-
Phenols[c]	mg/L	< 0.0050	< 0.0050	0.0053	< 0.0050
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	-	130	-	-
Fluoride[c]	mg/L	-	0.35	-	-
Sulfate[c]	mg/L	-	187	-	-
TOCs[c]	mg/L	2.4	2.9	2.1	2.8
TOCs[c]	mg/L	2.4	2.7	2.1	2.7
TOCs[c]	mg/L	2.3	2.7	2.1	2.7
TOCs[c]	mg/L	2.3	2.7	2.1	2.7
TOXs[c]	mg/L	0.012	0.039	0.042	0.250
TOXs[c]	mg/L	0.020	0.028	0.043	0.310

[a] Well point elevation = 181.35 m (MSL); ground surface elevation = 227.37 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

TABLE 6.30

Groundwater Monitoring Results, Sanitary Landfill Well 800201, 2002

Parameter	Unit	Date of Sampling 01/14/02	04/15/02	07/10/02	10/08/02
Water elevation[a]	m	224.04	224.70	224.03	223.34
Temperature	°C	9.9	11.5	12.5	10.6
pH	pH	7.06	6.94	6.87	6.83
Redox	mV	5	9	-2	-16
Conductivity	µmhos/cm	1,126	1,035	1,010	1,105
Chloride[b]	mg/L	12	13	13	15
Sulfate[b]	mg/L	57	58	69	62
TDS[b]	mg/L	702	724	724	709
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	0.0139	-	-
Barium[c]	mg/L	-	0.3345	-	-
Boron[c]	mg/L	-	0.1135	-	-
Cadmium[c]	mg/L	-	0.0003	-	-
Chromium[c]	mg/L	-	0.0772	-	-
Cobalt[c]	mg/L	-	< 0.016	-	-
Copper[c]	mg/L	-	0.0236	-	-
Iron[c]	mg/L	-	**25.28**[e]	-	-
Lead[c]	mg/L	-	**0.0129**	-	-
Manganese[c]	mg/L	-	**1.081**	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-
Nickel[c]	mg/L	-	0.0661	-	-
Selenium[c]	mg/L	-	< 0.003	-	-
Silver[c]	mg/L	-	0.0011	-	-
Zinc[c]	mg/L	-	0.083	-	-
Ammonia nitrogen[b]	mg/L	3.5	3.9	2.9	2.6
Arsenic[b]	mg/L	0.0085	0.0051	0.0054	0.0073
Barium[b]	mg/L	0.2608	0.2833	0.2483	0.2630
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.5554	2.5450	0.1165	0.7822
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	**0.38**	**0.4253**	**0.39**	**0.3961**
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.013	0.014	0.012	0.012
Nitrate[c]	mg/L	-	< 0.1	-	-
Phenols[c]	mg/L	< 0.005	0.019	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	-	12	-	-
Fluoride[c]	mg/L	-	0.202	-	-
Sulfate[c]	mg/L	-	56	-	-
TOCs[c]	mg/L	28.0	26.0	25.0	28.0
TOCs[c]	mg/L	28.0	26.0	26.0	29.0
TOCs[c]	mg/L	28.0	27.0	26.0	29.0
TOCs[c]	mg/L	28.0	27.0	26.0	29.0
TOXs[c]	mg/L	< 0.010	0.010	0.017	0.021
TOXs[c]	mg/L	0.014	0.030	0.020	< 0.020

[a] Well point elevation = 217.26 m (MSL); ground surface elevation = 227.93 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

[e] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.31

Groundwater Monitoring Results, Sanitary Landfill Well 800202, 2002

		Date of Sampling			
Parameter	Unit	01/14/02	04/15/02	07/10/02	10/08/02
Water elevation[a]	m	217.97	218.30	218.40	217.76
Temperature	°C	10.3	12.2	11.8	11.2
pH	pH	7.07	7.08	6.93	7.06
Redox	mV	3	-	-6	-29
Conductivity	µmhos/cm	1,085	964	966	1,036
Chloride[b]	mg/L	19	22	26	23
Sulfate[b]	mg/L	67	67	72	70
TDS[b]	mg/L	641	645	642	630
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	< 0.003	-	-
Barium[c]	mg/L	-	0.2062	-	-
Boron[c]	mg/L	-	0.151	-	-
Cadmium[c]	mg/L	-	< 0.0002	-	-
Chromium[c]	mg/L	-	< 0.024	-	-
Cobalt[c]	mg/L	-	< 0.016	-	-
Copper[c]	mg/L	-	< 0.015	-	-
Iron[c]	mg/L	-	**6.534**[e]	-	-
Lead[c]	mg/L	-	< 0.002	-	-
Manganese[c]	mg/L	-	0.1216	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-
Nickel[c]	mg/L	-	< 0.02	-	-
Selenium[c]	mg/L	-	< 0.003	-	-
Silver[c]	mg/L	-	0.0017	-	-
Zinc[c]	mg/L	-	< 0.008	-	-
Ammonia nitrogen[b]	mg/L	2.5	1.9	1.4	1.5
Arsenic[b]	mg/L	0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.1673	0.1989	0.1622	0.2053
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	3.848	**5.405**	2.763	**5.405**
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.1235	0.1229	0.1113	0.1114
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Nitrate[c]	mg/L	-	< 0.1	-	-
Phenols[c]	mg/L	< 0.005	0.014	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	-	21	-	-
Fluoride[c]	mg/L	-	0.232	-	-
Sulfate[c]	mg/L	-	70	-	-
TOCs[c]	mg/L	11	11	10	12
TOCs[c]	mg/L	11	10	10	12
TOCs[c]	mg/L	11	10	10	11
TOCs[c]	mg/L	11.0	10.0	9.9	12.0
TOXs[c]	mg/L	0.010	< 0.010	0.012	0.028
TOXs[c]	mg/L	< 0.010	< 0.010	0.016	< 0.020

[a] Well point elevation = 209.54 m (MSL); ground surface elevation = 227.92 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

[e] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.32

Groundwater Monitoring Results, Sanitary Landfill Well 800203D, 2002

Parameter	Unit	Date of Sampling 01/14/02	04/15/02	04/15/02	07/10/02	10/08/02
Water elevation[a]	m	192.47	192.47	192.47	192.40	192.16
Temperature	°C	10.1	12.6	12.6	13.1	11.3
pH	pH	7.10	7.00	7.00	6.81	6.99
Redox	mV	4	5	5	0	-25
Conductivity	µmhos/cm	1,166	1,004	1,004	1,034	1,069
Chloride[b]	mg/L	99	85	90	106	77
Sulfate[b]	mg/L	56	56	53	55	42
TDS[b]	mg/L	671	671	655	669	626
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	< 0.003	< 0.003	-	-
Barium[c]	mg/L	-	0.1161	0.1118	-	-
Boron[c]	mg/L	-	0.1923	0.1900	-	-
Cadmium[c]	mg/L	-	< 0.0002	< 0.0002	-	-
Chromium[c]	mg/L	-	< 0.024	< 0.024	-	-
Cobalt[c]	mg/L	-	0.0499	0.0565	-	-
Copper[c]	mg/L	-	< 0.015	< 0.015	-	-
Iron[c]	mg/L	-	1.518	1.450	-	-
Lead[c]	mg/L	-	< 0.002	< 0.002	-	-
Manganese[c]	mg/L	-	0.0419	0.0402	-	-
Mercury[c]	mg/L	-	< 0.0001	< 0.0001	-	-
Nickel[c]	mg/L	-	< 0.02	< 0.02	-	-
Selenium[c]	mg/L	-	< 0.003	< 0.003	-	-
Silver[c]	mg/L	-	< 0.001	< 0.001	-	-
Zinc[c]	mg/L	-	< 0.008	< 0.008	-	-
Ammonia nitrogen[b]	mg/L	2.0	2.1	1.9	1.4	1.2
Arsenic[b]	mg/L	0.005	0.0046	0.0034	< 0.003	0.0037
Barium[b]	mg/L	0.1100	0.1195	0.1133	0.1116	0.1159
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	0.0573	0.0479	0.0537	0.0620	0.0676
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.5215	1.3040	0.9161	0.0534	0.7449
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0491	0.0472	0.0482	0.0449	0.0388
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008
Nitrate[c]	mg/L	-	< 0.1	< 0.1	-	-
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	-	105	101	-	-
Fluoride[c]	mg/L	-	0.40	0.37	-	-
Sulfate[c]	mg/L	-	54	56	-	-
TOCs[c]	mg/L	4.7	4.0	4.0	4.3	5.0
TOCs[c]	mg/L	4.8	4.4	4.0	4.3	5.0
TOCs[c]	mg/L	4.8	4.0	4.1	4.4	5.0
TOCs[c]	mg/L	4.8	4.0	4.0	4.4	5.0
TOXs[c]	mg/L	0.013	0.028	0.083	0.035	0.045
TOXs[c]	mg/L	0.014	0.016	0.056	0.033	0.024

[a] Well point elevation = 189.59 m (MSL); ground surface elevation = 227.92 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

TABLE 6.33

Groundwater Monitoring Results, Sanitary Landfill Well 800271, 2002

		Date of Sampling			
Parameter	Unit	01/22/02	04/16/02	07/08/02	10/07/02
Water elevation[a]	m	224.34	225.32	223.89	223.13
Temperature	°C	8.9	8.8	13.0	13.6
pH	pH	6.93	7.34	7.03	7.27
Redox	mV	18	-15	-9	-39
Conductivity	µmhos/cm	624	614	619	673
Chloride[b]	mg/L	3	4	1	1
Sulfate[b]	mg/L	42	35	42	51
TDS[b]	mg/L	407	411	407	407
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	< 0.003	-	-
Barium[c]	mg/L	-	0.0452	-	-
Boron[c]	mg/L	-	0.1215	-	-
Cadmium[c]	mg/L	-	< 0.0002	-	-
Chromium[c]	mg/L	-	< 0.024	-	-
Cobalt[c]	mg/L	-	< 0.016	-	-
Copper[c]	mg/L	-	0.0175	-	-
Iron[c]	mg/L	-	**18.47**[e]	-	-
Lead[c]	mg/L	-	**0.0107**	-	-
Manganese[c]	mg/L	-	**0.2568**	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-
Nickel[c]	mg/L	-	0.0228	-	-
Selenium[c]	mg/L	-	< 0.003	-	-
Silver[c]	mg/L	-	0.0037	-	-
Zinc[c]	mg/L	-	0.065	-	-
Ammonia nitrogen[b]	mg/L	< 0.1	0.59	0.11	0.32
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0164	0.0185	0.0202	0.0183
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.0299	0.0261	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0101	< 0.01	0.0216	0.0295
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Nitrate[c]	mg/L	-	< 0.1	-	-
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	-	3	-	-
Fluoride[c]	mg/L	-	0.187	-	-
Sulfate[c]	mg/L	-	34	-	-
TOCs[c]	mg/L	1.3	1.3	1.4	1.7
TOCs[c]	mg/L	1.2	1.2	1.4	1.5
TOCs[c]	mg/L	1.2	1.2	1.4	1.4
TOCs[c]	mg/L	1.2	1.2	1.4	1.5
TOXs[c]	mg/L	0.038	0.014	0.014	0.032
TOXs[c]	mg/L	0.077	< 0.010	0.017	0.023

[a] Well point elevation = 221.65 m (MSL); ground surface elevation = 223.18 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

[e] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.34

Groundwater Monitoring Results, Sanitary Landfill Well 800273D, 2002

		Date of Sampling			
Parameter	Unit	01/22/02	04/16/02	07/08/02	10/07/02
Water elevation[a]	m	192.51	192.70	192.66	192.40
Temperature	°C	10.4	13.2	12.8	11.0
pH	pH	6.89	7.21	6.81	6.99
Redox	mV	17	-9	7	-25
Conductivity	µmhos/cm	1,140	1,129	1,178	1,213
Chloride[b]	mg/L	121	120	155	112
Sulfate[b]	mg/L	136	102	144	140
TDS[b]	mg/L	759	752	894	756
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	< 0.003	-	-
Barium[c]	mg/L	-	0.0477	-	-
Boron[c]	mg/L	-	0.2728	-	-
Cadmium[c]	mg/L	-	< 0.0002	-	-
Chromium[c]	mg/L	-	< 0.024	-	-
Cobalt[c]	mg/L	-	< 0.016	-	-
Copper[c]	mg/L	-	< 0.015	-	-
Iron[c]	mg/L	-	1.475	-	-
Lead[c]	mg/L	-	< 0.002	-	-
Manganese[c]	mg/L	-	< 0.01	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-
Nickel[c]	mg/L	-	< 0.02	-	-
Selenium[c]	mg/L	-	< 0.003	-	-
Silver[c]	mg/L	-	< 0.001	-	-
Zinc[c]	mg/L	-	< 0.008	-	-
Ammonia nitrogen[b]	mg/L	0.74	0.79	0.75	0.72
Arsenic[b]	mg/L	0.0046	0.0034	0.0040	0.0048
Barium[b]	mg/L	0.0483	0.0468	0.0501	0.0481
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	1.221	1.119	0.9814	1.478
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.011	0.0109	0.01	0.0102
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Nitrate[c]	mg/L	-	< 0.1	-	-
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	-	117	-	-
Fluoride[c]	mg/L	-	0.358	-	-
Sulfate[c]	mg/L	-	104	-	-
TOCs[c]	mg/L	1.2	1.2	1.2	1.3
TOCs[c]	mg/L	1.2	1.1	1.2	1.3
TOCs[c]	mg/L	1.2	1.8	1.2	1.3
TOCs[c]	mg/L	1.2	1.1	1.2	1.2
TOXs[c]	mg/L	0.018	0.047	0.017	0.043
TOXs[c]	mg/L	0.037	0.019	0.025	0.038

[a] Well point elevation = 188.73 m (MSL); ground surface elevation = 225.61 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

TABLE 6.35

Groundwater Monitoring Results, Sanitary Landfill Well 800281, 2002

		Date of Sampling			
Parameter	Unit	01/22/02	04/23/02	07/16/02	10/15/02
Water elevation[a]	m	226.14	227.20	225.88	224.54
Temperature	°C	8.7	8.1	12.0	12.2
pH	pH	6.95	6.87	6.75	6.83
Redox	mV	14	13	2	-14
Conductivity	µmhos/cm	1,195	1,078	1,118	1,476
Chloride[b]	mg/L	87	96	71	105
Sulfate[b]	mg/L	106	122	104	68
TDS[b]	mg/L	784	763	908	927
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	0.0035	-	-
Barium[c]	mg/L	-	0.171	-	-
Boron[c]	mg/L	-	0.3275	-	-
Cadmium[c]	mg/L	-	0.0002	-	-
Chromium[c]	mg/L	-	**0.3806**[e]	-	-
Cobalt[c]	mg/L	-	0.0168	-	-
Copper[c]	mg/L	-	0.0384	-	-
Iron[c]	mg/L	-	**32.47**	-	-
Lead[c]	mg/L	-	**0.0163**	-	-
Manganese[c]	mg/L	-	**1.464**	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-
Nickel[c]	mg/L	-	**0.1185**	-	-
Selenium[c]	mg/L	-	< 0.003	-	-
Silver[c]	mg/L	-	< 0.001	-	-
Zinc[c]	mg/L	-	0.100	-	-
Ammonia nitrogen[b]	mg/L	< 0.1	0.08	< 0.05	0.12
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0744	0.0776	0.0694	0.1234
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	0.034
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	1.308	0.723	0.6792	**8.077**
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	**0.9133**	**1.153**	**1.01**	**1.806**
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	0.3376	0.1949	0.5071	1.805
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.008	0.011	< 0.008	0.021
Nitrate[c]	mg/L	-	< 0.1	-	-
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	0.018
Hydrogen-3[c]	pCi/L	307	203	225	420
Chloride[c]	mg/L	-	91	-	-
Fluoride[c]	mg/L	-	0.163	-	-
Sulfate[c]	mg/L	-	116	-	-
TOCs[c]	mg/L	2.1	2.5	2.4	3.8
TOCs[c]	mg/L	2.2	2.5	2.3	3.7
TOCs[c]	mg/L	2.2	2.2	2.4	3.7
TOCs[c]	mg/L	2.1	2.6	2.4	3.8
TOXs[c]	mg/L	0.055	0.039	0.051	0.046
TOXs[c]	mg/L	0.037	0.057	0.050	0.057

[a] Well point elevation = 224.00 m (MSL); ground surface elevation = 227.65 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

[e] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.36

Groundwater Monitoring Results, Sanitary Landfill Well 800291, 2002

Parameter	Unit	Date of Sampling 01/22/02	04/23/02	07/17/02	10/15/02
Water elevation[a]	m	228.34	229.29	227.64	226.58
Temperature	°C	10.4	9.7	6.1	10.6
pH	pH	7.22	6.99	6.99	7.11
Redox	mV	-1	4	-13	-28
Conductivity	µmhos/cm	1,136	1,128	1,137	1,208
Chloride[b]	mg/L	9	8	8	7
Sulfate[b]	mg/L	286	248	288	272
TDS[b]	mg/L	835	802	807	792
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	0.0102	-	-
Barium[c]	mg/L	-	0.1545	-	-
Boron[c]	mg/L	-	0.2013	-	-
Cadmium[c]	mg/L	-	0.0003	-	-
Chromium[c]	mg/L	-	0.0473	-	-
Cobalt[c]	mg/L	-	0.0229	-	-
Copper[c]	mg/L	-	0.0559	-	-
Iron[c]	mg/L	-	**54.48**[e]	-	-
Lead[c]	mg/L	-	**0.0387**	-	-
Manganese[c]	mg/L	-	**0.9987**	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-
Nickel[c]	mg/L	-	0.0672	-	-
Selenium[c]	mg/L	-	< 0.003	-	-
Silver[c]	mg/L	-	0.0016	-	-
Zinc[c]	mg/L	-	0.129	-	-
Ammonia nitrogen[b]	mg/L	< 0.10	0.04	0.04	0.09
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0282	0.0259	0.0272	0.0294
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.2060	0.1165	0.1137	0.0589
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	**0.1505**	0.1381	**0.1561**	**0.1631**
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Nitrate[c]	mg/L	-	< 0.1	-	-
Phenols[c]	mg/L	< 0.0050	0.0057	< 0.0050	< 0.0050
Hydrogen-3[c]	pCi/L	188	< 100	< 100	< 100
Chloride[c]	mg/L	-	7	-	-
Fluoride[c]	mg/L	-	0.304	-	-
Sulfate[c]	mg/L	-	255	-	-
TOCs[c]	mg/L	1.9	2.5	2.2	2.6
TOCs[c]	mg/L	1.9	2.2	2.2	2.5
TOCs[c]	mg/L	1.8	2.4	2.3	2.6
TOCs[c]	mg/L	1.9	2.2	2.2	2.6
TOXs[c]	mg/L	< 0.010	0.017	0.013	0.022
TOXs[c]	mg/L	0.013	0.022	0.010	0.026

[a] Well point elevation = 223.48 m (MSL); ground surface elevation = 230.49 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

[e] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.37

Groundwater Monitoring Results, Sanitary Landfill Well 800301, 2002

		Date of Sampling				
Parameter	Unit	01/07/02	01/07/02	05/01/02	07/23/02	10/14/02
Water elevation[a]	m	226.87	226.87	231.98	229.19	227.48
Temperature	°C	8.9	8.9	9.8	10.0	10.3
pH	pH	7.17	7.17	7.02	7.09	7.03
Redox	mV	1	1	3	-19	-28
Conductivity	µmhos/cm	1,108	1,108	965	963	1,036
Chloride[b]	mg/L	7	7	8	7	6
Sulfate[b]	mg/L	93	160	194	159	126
TDS[b]	mg/L	693	713	687	696	654
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	-	0.0165	-	-
Barium[c]	mg/L	-	-	0.0969	-	-
Boron[c]	mg/L	-	-	0.1536	-	-
Cadmium[c]	mg/L	-	-	0.0002	-	-
Chromium[c]	mg/L	-	-	< 0.024	-	-
Cobalt[c]	mg/L	-	-	< 0.016	-	-
Copper[c]	mg/L	-	-	0.039	-	-
Iron[c]	mg/L	-	-	**41.96**[e]	-	-
Lead[c]	mg/L	-	-	**0.0272**	-	-
Manganese[c]	mg/L	-	-	**0.7186**	-	-
Mercury[c]	mg/L	-	-	< 0.0001	-	-
Nickel[c]	mg/L	-	-	0.0378	-	-
Selenium[c]	mg/L	-	-	< 0.003	-	-
Silver[c]	mg/L	-	-	0.0018	-	-
Zinc[c]	mg/L	-	-	0.085	-	-
Ammonia nitrogen[b]	mg/L	< 0.1	< 0.1	0.17	0.21	0.08
Arsenic[b]	mg/L	< 0.003	< 0.003	0.007	< 0.003	0.0034
Barium[b]	mg/L	0.0233	0.0223	0.0218	0.0227	0.0219
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.0374	0.0420	0.6446	0.4359	0.3089
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.1048	0.0998	0.0647	0.0893	0.0873
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	0.012	< 0.008	0.009	0.009
Nitrate[c]	mg/L	-	-	< 0.1	-	-
Phenols[c]	mg/L	< 0.005	< 0.005	0.013	0.052	0.0058
Hydrogen-3[c]	pCi/L	< 100	< 100	121	< 100	< 100
Chloride[c]	mg/L	-	-	7	-	-
Fluoride[c]	mg/L	-	-	0.244	-	-
Sulfate[c]	mg/L	-	-	198	-	-
TOCs[c]	mg/L	1.7	1.4	1.5	1.4	1.6
TOCs[c]	mg/L	1.6	1.5	1.5	1.4	1.6
TOCs[c]	mg/L	1.6	1.4	1.5	1.5	1.6
TOCs[c]	mg/L	1.6	1.3	1.5	1.4	1.9
TOXs[c]	mg/L	< 0.010	< 0.010	0.011	< 0.010	< 0.020
TOXs[c]	mg/L	< 0.010	< 0.010	< 0.010	< 0.010	< 0.020

[a] Well point elevation = 224.99 m (MSL); ground surface elevation = 232.53 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

[e] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.38

Groundwater Monitoring Results,
Sanitary Landfill Well 800321, 2002

Parameter	Unit	Date of Sampling 01/07/02	05/01/02
Water elevation[a]	m	225.69	227.12
Temperature	°C	10.2	9.2
pH	pH	7.14	7.02
Redox	mV	4	2
Conductivity	µmhos/cm	1,882	1,460
Chloride[b]	mg/L	85	62
Sulfate[b]	mg/L	**818**[d]	**1,020**
TDS[b]	mg/L	**2,680**	**2,155**
Cyanide (total)[c]	mg/L	< 0.01	< 0.01
Arsenic[c]	mg/L	-[e]	< 0.003
Barium[c]	mg/L	-	0.0179
Boron[c]	mg/L	-	0.0969
Cadmium[c]	mg/L	-	< 0.0002
Chromium[c]	mg/L	-	< 0.024
Cobalt[c]	mg/L	-	< 0.016
Copper[c]	mg/L	-	< 0.015
Iron[c]	mg/L	-	2.432
Lead[c]	mg/L	-	0.0023
Manganese[c]	mg/L	-	0.1237
Mercury[c]	mg/L	-	< 0.0001
Nickel[c]	mg/L	-	< 0.02
Selenium[c]	mg/L	-	< 0.003
Silver[c]	mg/L	-	0.0011
Zinc[c]	mg/L	-	0.012
Ammonia nitrogen[b]	mg/L	0.15	0.10
Arsenic[b]	mg/L	< 0.003	< 0.003
Barium[b]	mg/L	0.0119	0.0129
Beryllium[b]	mg/L	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015
Iron[b]	mg/L	< 0.0200	0.0301
Lead[b]	mg/L	< 0.002	< 0.002
Manganese[b]	mg/L	**0.3261**	0.0135
Mercury[b]	mg/L	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032
Zinc[b]	mg/L	0.040	< 0.0080
Nitrate[c]	mg/L	-	< 0.1
Phenols[c]	mg/L	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100
Chloride[c]	mg/L	-	50
Fluoride[c]	mg/L	-	0.153
Sulfate[c]	mg/L	-	**990**
TOCs[c]	mg/L	1.5	1.8
TOCs[c]	mg/L	1.6	1.7
TOCs[c]	mg/L	1.5	1.6
TOCs[c]	mg/L	1.5	1.7
TOXs[c]	mg/L	< 0.010	0.014
TOXs[c]	mg/L	< 0.010	0.017

[a] Well point elevation = 223.66 m (MSL); ground surface elevation = 227.93 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

[e] A hyphen indicates that no samples were collected.

TABLE 6.39

Groundwater Monitoring Results, Sanitary Landfill Well 800331, 2002

		Date of Sampling				
Parameter	Unit	01/22/02	04/29/02	04/29/02	07/16/02	10/15/02
Water elevation[a]	m	226.54	227.39	227.39	225.79	224.80
Temperature	°C	9.6	8.1	8.1	12.4	12.3
pH	pH	7.36	6.89	6.89	7.24	6.98
Redox	mV	-5	7	7	-26	-27
Conductivity	µmhos/cm	986	966	-	940	1,014
Chloride[b]	mg/L	7	8	7	6	5
Sulfate[b]	mg/L	208	154	166	199	232
TDS[b]	mg/L	715	681	671	678	700
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L'	-[d]	< 0.003	< 0.003	-	-
Barium[c]	mg/L	-	0.0421	0.0456	-	-
Boron[c]	mg/L	-	0.0508	0.0689	-	-
Cadmium[c]	mg/L	-	< 0.0002	< 0.0002	-	-
Chromium[c]	mg/L	-	< 0.024	< 0.024	-	-
Cobalt[c]	mg/L	-	< 0.016	< 0.016	-	-
Copper[c]	mg/L	-	< 0.015	< 0.015	-	-
Iron[c]	mg/L	-	3.685	3.484	-	-
Lead[c]	mg/L	-	0.0035	0.0030	-	-
Manganese[c]	mg/L	-	0.1156	0.1255	-	-
Mercury[c]	mg/L	-	< 0.0001	< 0.0001	-	-
Nickel[c]	mg/L	-	< 0.02	< 0.02	-	-
Selenium[c]	mg/L	-	< 0.003	< 0.003	-	-
Silver[c]	mg/L	-	0.0027	< 0.0010	-	-
Zinc[c]	mg/L	-	0.020	0.025	-	-
Ammonia nitrogen[b]	mg/L	< 0.10	0.08	0.04	0.03	0.06
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0393	0.0408	0.0415	0.0391	0.0417
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.0150	< 0.0150	0.0154	< 0.0150	< 0.0150
Iron[b]	mg/L	0.0244	< 0.0200	< 0.0200	< 0.0200	< 0.0200
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0480	0.0248	0.0278	0.0412	0.0107
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.0200	< 0.0200	< 0.0200	< 0.0200	0.0542
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	0.018	0.021	0.013	0.034
Nitrate[c]	mg/L	-	< 0.1	< 0.1	-	-
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.050	< 0.005
Hydrogen-3[c]	pCi/L	137	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	-	8	8	-	-
Fluoride[c]	mg/L	-	0.316	0.302	-	-
Sulfate[c]	mg/L	-	156	162	-	-
TOCs[c]	mg/L	1.4	1.5	1.5	1.6	1.7
TOCs[c]	mg/L	1.4	1.5	1.5	1.6	1.6
TOCs[c]	mg/L	1.3	1.6	1.5	1.6	1.7
TOCs[c]	mg/L	1.5	1.6	1.5	1.6	1.5
TOXs[c]	mg/L	< 0.010	0.011	0.017	< 0.010	0.029
TOXs[c]	mg/L	0.037	0.012	0.030	< 0.010	0.028

[a] Well point elevation = 222.75 m (MSL); ground surface elevation = 227.93 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

TABLE 6.40

Groundwater Monitoring Results, Sanitary Landfill Well 800341, 2002

Parameter	Unit	Date of Sampling 01/22/02	04/24/02	07/17/02	10/15/02
Water elevation[a]	m	229.65	229.85	228.40	227.38
Temperature	°C	8.6	8.0	7.4	13.6
pH	pH	7.37	7.22	7.00	7.05
Redox	mV	-9	-8	-14	-28
Conductivity	µmhos/cm	1,105	1,096	1,112	1,166
Chloride[b]	mg/L	16	15	15	14
Sulfate[b]	mg/L	316	267	324	296
TDS[b]	mg/L	812	811	832	807
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	0.0051	-	-
Barium[c]	mg/L	-	0.0834	-	-
Boron[c]	mg/L	-	0.1053	-	-
Cadmium[c]	mg/L	-	0.0002	-	-
Chromium[c]	mg/L	-	< 0.024	-	-
Cobalt[c]	mg/L	-	< 0.016	-	-
Copper[c]	mg/L	-	0.024	-	-
Iron[c]	mg/L	-	**22.37**[e]	-	-
Lead[c]	mg/L	-	**0.0141**	-	-
Manganese[c]	mg/L	-	**0.4578**	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-
Nickel[c]	mg/L	-	0.0276	-	-
Selenium[c]	mg/L	-	< 0.003	-	-
Silver[c]	mg/L	-	0.0016	-	-
Zinc[c]	mg/L	-	0.067	-	-
Ammonia nitrogen[b]	mg/L	< 0.1	< 0.05	< 0.05	< 0.05
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0361	0.0362	0.0405	0.0442
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.058	0.1008	0.026	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	0.008
Nitrate[c]	mg/L	-	0.27	-	-
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	108	< 100	< 100	< 100
Chloride[c]	mg/L	-	15	-	-
Fluoride[c]	mg/L	-	0.308	-	-
Sulfate[c]	mg/L	-	274	-	-
TOCs[c]	mg/L	2.3	2.2	2.3	2.4
TOCs[c]	mg/L	2.2	2.4	2.3	2.4
TOCs[c]	mg/L	2.3	2.4	2.4	2.3
TOCs[c]	mg/L	2.3	2.4	2.3	2.3
TOXs[c]	mg/L	< 0.010	0.012	0.016	0.025
TOXs[c]	mg/L	< 0.010	0.017	0.020	0.029

[a] Well point elevation = 226.01 m (MSL); ground surface elevation = 229.97 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

[e] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.41

Groundwater Monitoring Results, Sanitary Landfill Well 800351, 2002

Parameter	Unit	Date of Sampling 01/07/02	04/29/02	07/23/02	10/14/02
Water elevation[a]	m	226.28	229.32	227.39	225.98
Temperature	°C	9.3	10.5	10.8	10.2
pH	pH	7.19	7.09	7.34	7.06
Redox	mV	-3	-	-33	-31
Conductivity	µmhos/cm	958	863	866	934
Chloride[b]	mg/L	4	4	2	3
Sulfate[b]	mg/L	47	47	54	50
TDS[b]	mg/L	562	540	558	557
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	0.0089	-	-
Barium[c]	mg/L	-	0.1195	-	-
Boron[c]	mg/L	-	0.1473	-	-
Cadmium[c]	mg/L	-	0.0002	-	-
Chromium[c]	mg/L	-	0.0263	-	-
Cobalt[c]	mg/L	-	< 0.016	-	-
Copper[c]	mg/L	-	0.0259	-	-
Iron[c]	mg/L	-	**25.83**[e]	-	-
Lead[c]	mg/L	-	**0.0166**	-	-
Manganese[c]	mg/L	-	**0.3969**	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-
Nickel[c]	mg/L	-	0.0259	-	-
Selenium[c]	mg/L	-	< 0.003	-	-
Silver[c]	mg/L	-	0.0016	-	-
Zinc[c]	mg/L	-	0.055	-	-
Ammonia nitrogen[b]	mg/L	0.30	0.14	0.18	0.06
Arsenic[b]	mg/L	< 0.0030	0.0033	< 0.0030	0.0031
Barium[b]	mg/L	0.0794	0.0986	0.0911	0.0925
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.0200	0.8595	< 0.0200	0.5044
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0257	0.0249	0.0310	0.0279
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.001
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	0.010	< 0.008
Nitrate[c]	mg/L	-	< 0.1	-	-
Phenols[c]	mg/L	< 0.0050	< 0.0050	0.0097	0.0071
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	-	4	-	-
Fluoride[c]	mg/L	-	0.316	-	-
Sulfate[c]	mg/L	-	49	-	-
TOCs[c]	mg/L	1.5	1.6	1.6	1.5
TOCs[c]	mg/L	1.5	1.6	1.6	1.5
TOCs[c]	mg/L	1.6	1.6	1.6	1.5
TOCs[c]	mg/L	1.5	1.6	1.6	1.5
TOXs[c]	mg/L	< 0.010	< 0.010	< 0.010	0.022
TOXs[c]	mg/L	< 0.010	< 0.010	< 0.010	0.036

[a] Well point elevation = 220.86 m (MSL); ground surface elevation = 232.75 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

[e] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.42

Groundwater Monitoring Results, Sanitary Landfill Well 800361, 2002

		Date of Sampling				
Parameter	Unit	01/08/02	04/30/02	07/23/02	07/23/02	10/14/02
Water elevation[a]	m	225.93	227.10	224.63	224.63	222.37
Temperature	°C	10.7	9.9	10.5	10.5	10.8
pH	pH	6.78	6.96	7.00	7.99	7.11
Redox	mV	21	5	-12	-12	-31
Conductivity	μmhos/cm	895	789	799	799	870
Chloride[b]	mg/L	9	13	13	12	11
Sulfate[b]	mg/L	143	130	167	87	128
TDS[b]	mg/L	560	534	579	582	553
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	0.016	< 0.01	< 0.01
Arsenic[c]	mg/L	-[d]	0.0046	-	-	-
Barium[c]	mg/L	-	0.0536	-	-	-
Boron[c]	mg/L	-	0.0688	-	-	-
Cadmium[c]	mg/L	-	< 0.0002	-	-	-
Chromium[c]	mg/L	-	< 0.024	-	-	-
Cobalt[c]	mg/L	-	< 0.016	-	-	-
Copper[c]	mg/L	-	< 0.015	-	-	-
Iron[c]	mg/L	-	**8.119**[e]	-	-	-
Lead[c]	mg/L	-	0.0052	-	-	-
Manganese[c]	mg/L	-	**0.2045**	-	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-	-
Nickel[c]	mg/L	-	< 0.02	-	-	-
Selenium[c]	mg/L	-	< 0.003	-	-	-
Silver[c]	mg/L	-	< 0.001	-	-	-
Zinc[c]	mg/L	-	0.035	-	-	-
Ammonia nitrogen[b]	mg/L	< 0.1	0.07	0.11	0.08	0.09
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0285	0.0312	0.0327	0.0334	0.031
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.0409	0.2025	0.0595	0.1517	0.0606
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0679	0.0765	0.0813	0.0766	0.0921
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.009	< 0.008	0.011	0.015	< 0.008
Nitrate[c]	mg/L	-	< 0.1	-	-	-
Phenols[c]	mg/L	0.042	< 0.005	0.0051	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	137	< 100
Chloride[c]	mg/L	-	14	-	-	-
Fluoride[c]	mg/L	-	0.246	-	-	-
Sulfate[c]	mg/L	-	133	-	-	-
TOCs[c]	mg/L	1.4	1.7	1.7	1.6	1.6
TOCs[c]	mg/L	1.4	1.8	1.7	1.7	1.7
TOCs[c]	mg/L	1.5	1.7	1.7	1.7	1.7
TOCs[c]	mg/L	1.5	1.7	1.7	1.8	1.7
TOXs[c]	mg/L	< 0.010	0.018	< 0.010	< 0.010	0.030
TOXs[c]	mg/L	< 0.010	0.019	< 0.010	< 0.010	0.038

[a] Well bottom elevation = 220.60 m (MSL); ground surface elevation = 227.53 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

[e] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.43

Groundwater Monitoring Results, Sanitary Landfill Well 800371, 2002

		Date of Sampling			
Parameter	Unit	01/08/02	04/29/02	07/23/02	10/14/02
Water elevation[a]	m	219.42	219.41	219.53	219.36
Temperature	°C	9.7	10.8	10.8	11.1
pH	pH	7.11	7.28	7.00	7.17
Redox	mV	-[d]	-11	-13	-35
Conductivity	µmhos/cm	854	749	757	813
Chloride[b]	mg/L	4	4	1	1
Sulfate[b]	mg/L	65	39	65	44
TDS[b]	mg/L	504	487	505	474
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	-	0.0071	-	-
Barium[c]	mg/L	-	0.32	-	-
Boron[c]	mg/L	-	0.4258	-	-
Cadmium[c]	mg/L	-	0.0018	-	-
Chromium[c]	mg/L	-	0.0673	-	-
Cobalt[c]	mg/L	-	0.0389	-	-
Copper[c]	mg/L	-	0.1759	-	-
Iron[c]	mg/L	-	**114.5**[e]	-	-
Lead[c]	mg/L	-	**0.0623**	-	-
Manganese[c]	mg/L	-	**2.431**	-	-
Mercury[c]	mg/L	-	< 0.0001	-	-
Nickel[c]	mg/L	-	**0.1178**	-	-
Selenium[c]	mg/L	-	< 0.003	-	-
Silver[c]	mg/L	-	< 0.001	-	-
Zinc[c]	mg/L	-	0.451	-	-
Ammonia nitrogen[b]	mg/L	0.80	0.56	0.15	0.08
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0639	0.0787	0.0851	0.0982
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.0707	0.0501	0.0219	< 0.0200
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0688	0.0733	0.0965	0.1134
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	0.018
Nitrate[c]	mg/L	-	< 0.1	-	-
Phenols[c]	mg/L	< 0.0050	0.0074	0.0080	< 0.0050
Hydrogen-3[c]	pCi/L	< 100	125	< 100	< 100
Chloride[c]	mg/L	-	4	-	-
Fluoride[c]	mg/L	-	0.406	-	-
Sulfate[c]	mg/L	-	37	-	-
TOCs[c]	mg/L	1.7	1.8	1.6	1.6
TOCs[c]	mg/L	1.7	1.6	1.6	1.6
TOCs[c]	mg/L	1.7	1.8	1.6	1.6
TOCs[c]	mg/L	1.9	1.6	1.6	1.6
TOXs[c]	mg/L	< 0.010	< 0.010	< 0.010	0.030
TOXs[c]	mg/L	< 0.010	0.013	< 0.010	0.026

[a] Well point elevation = 217.83 m (MSL); ground surface elevation = 227.50 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A hyphen indicates that no samples were collected.

[e] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

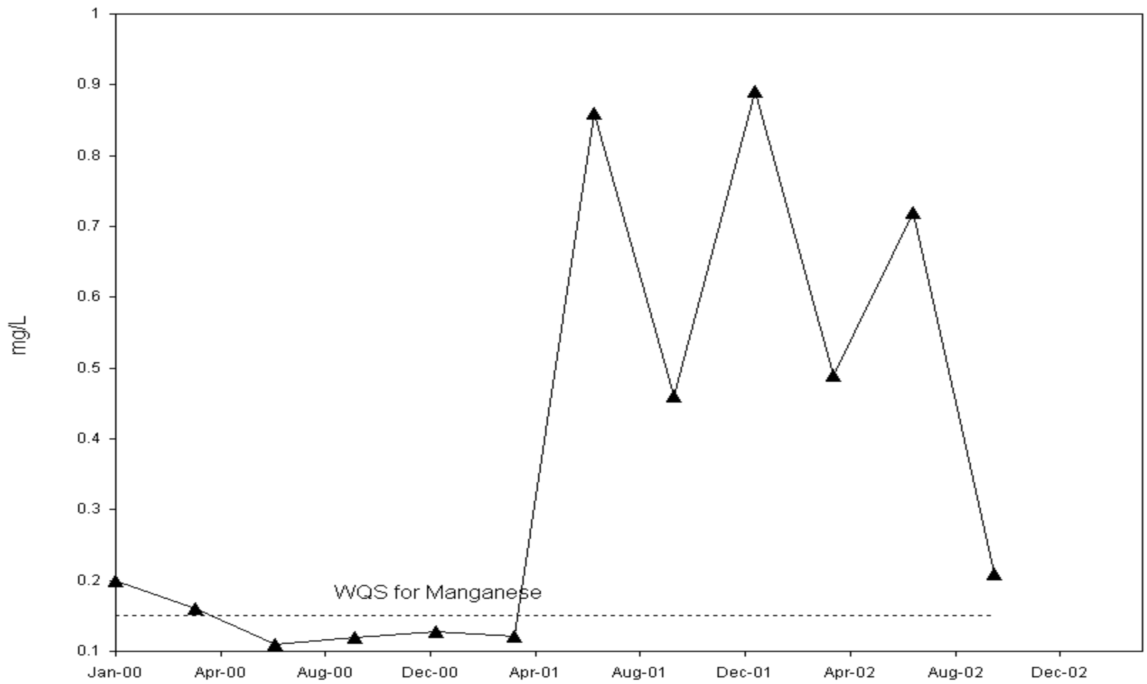


Figure 6.14 Well 800381 Manganese Results

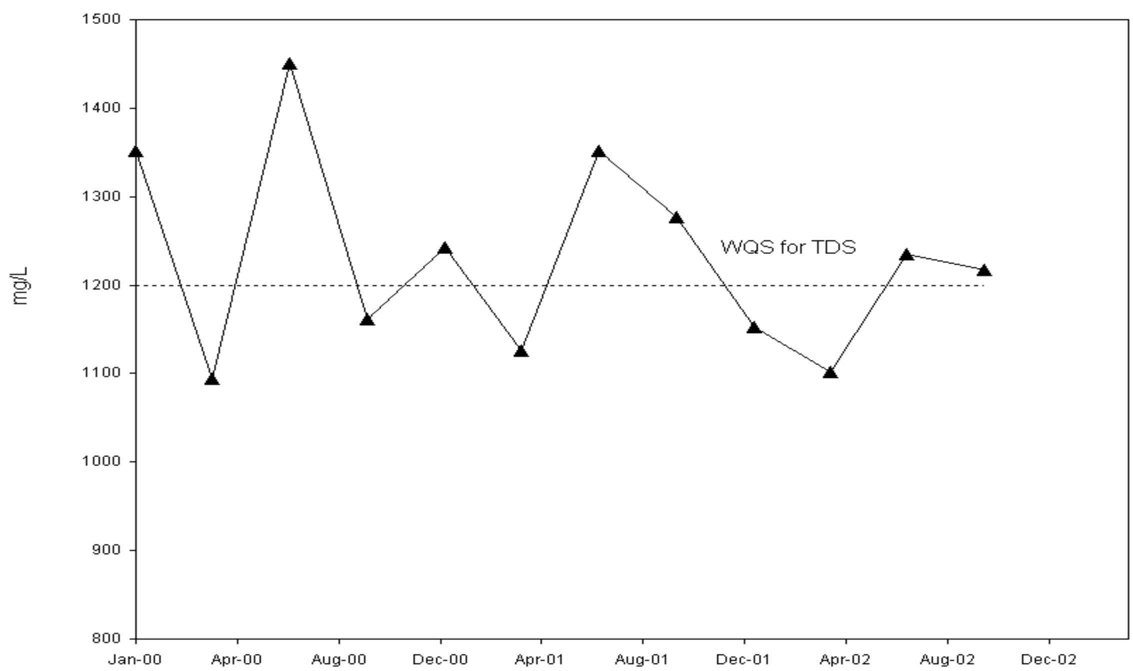


Figure 6.15 Well 800381 TDS Results

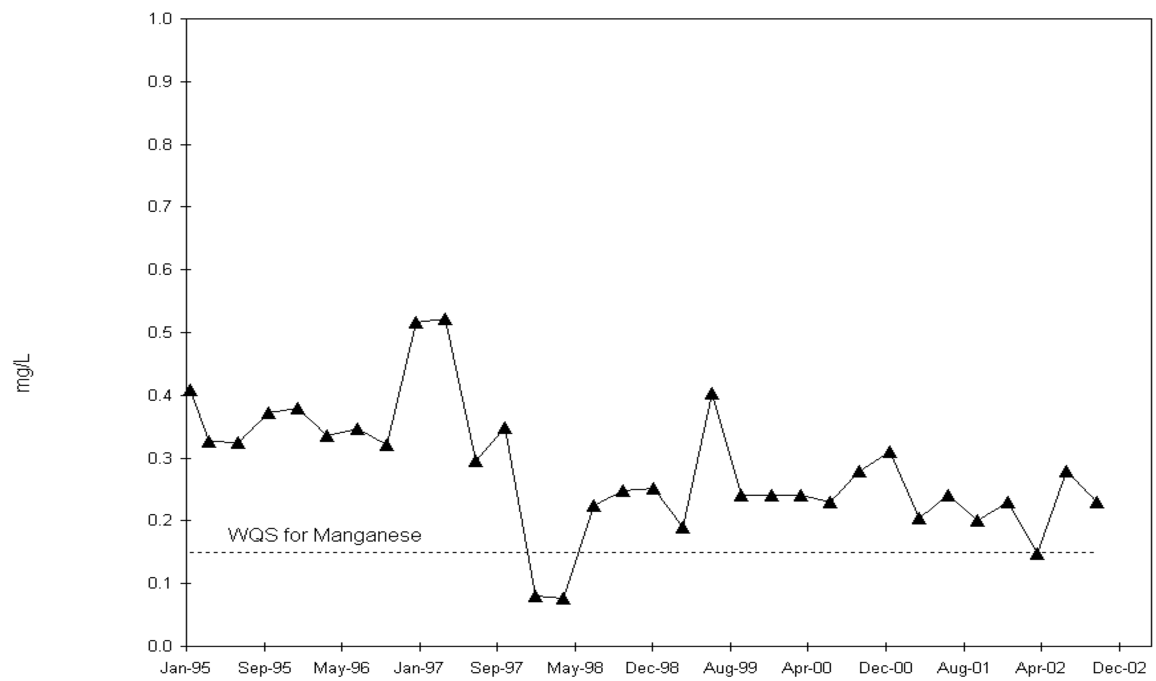


Figure 6.16 Well 800171 Manganese Results

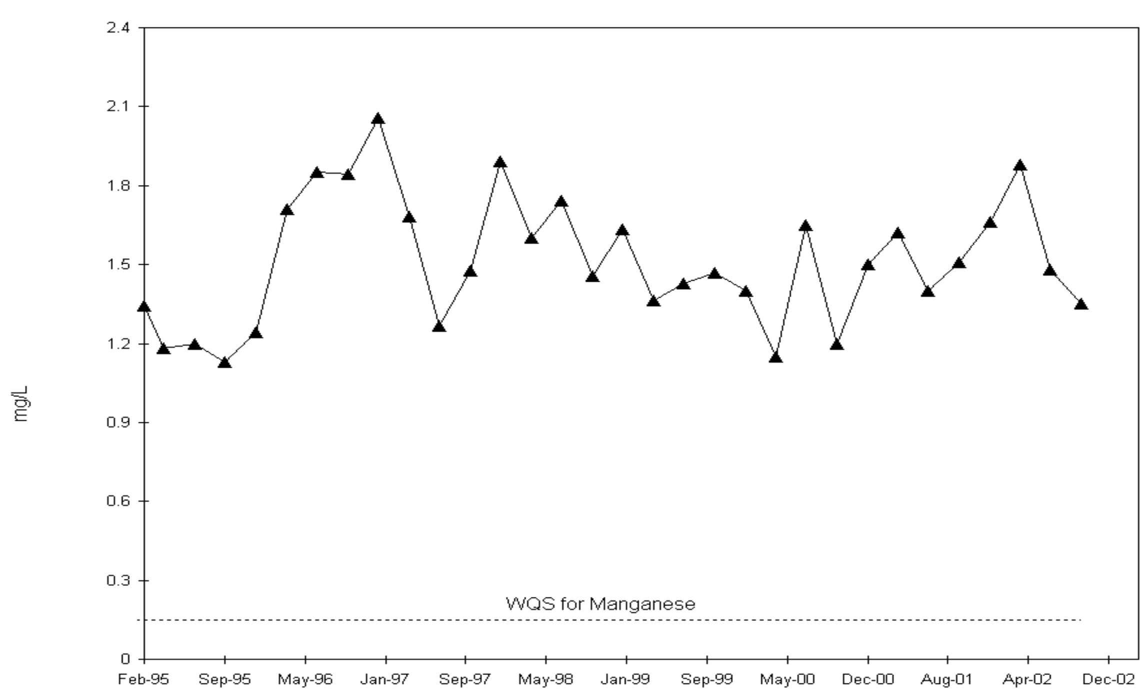


Figure 6.17 Well 800191 Manganese Results

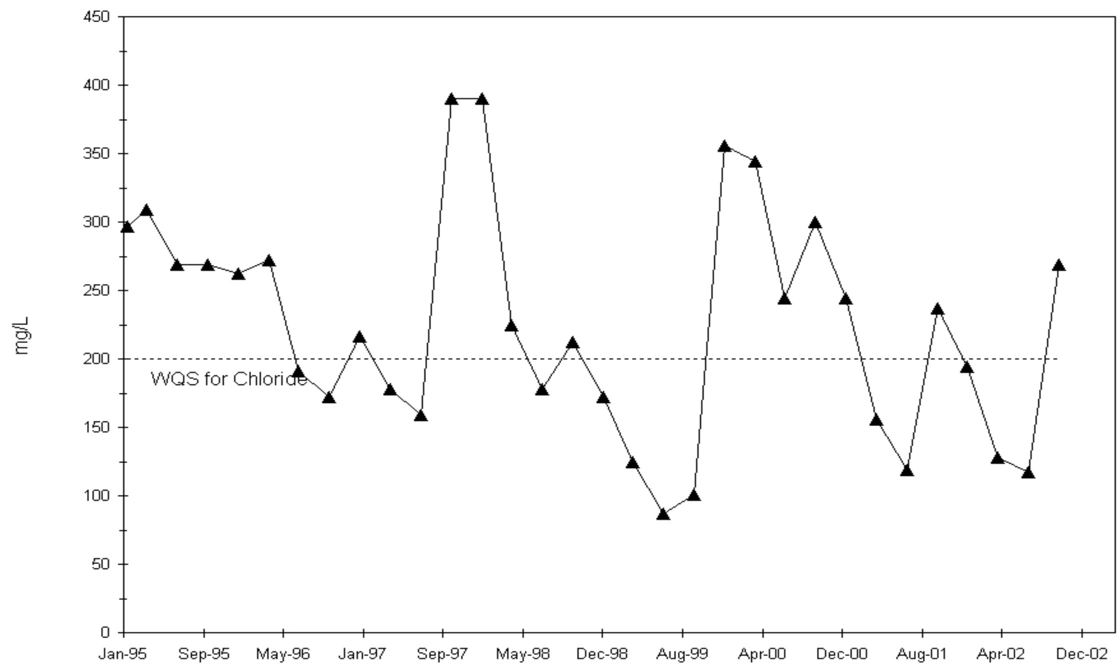


Figure 6.18 Well 800191 Chloride Results

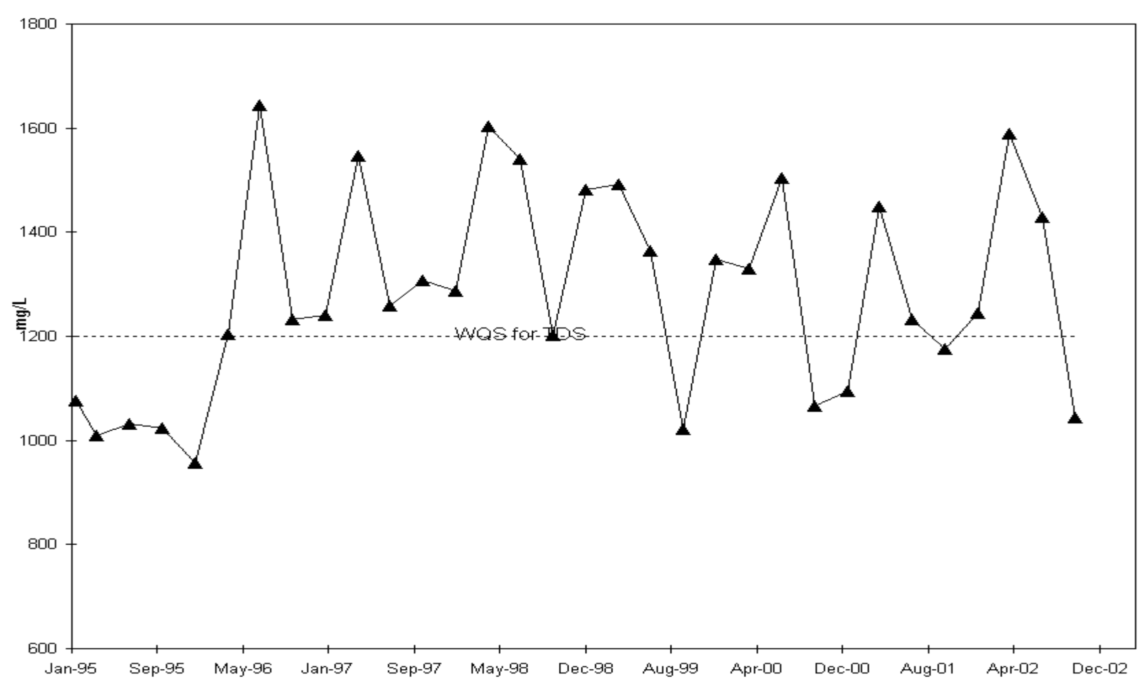


Figure 6.19 Well 800191 TDS Results

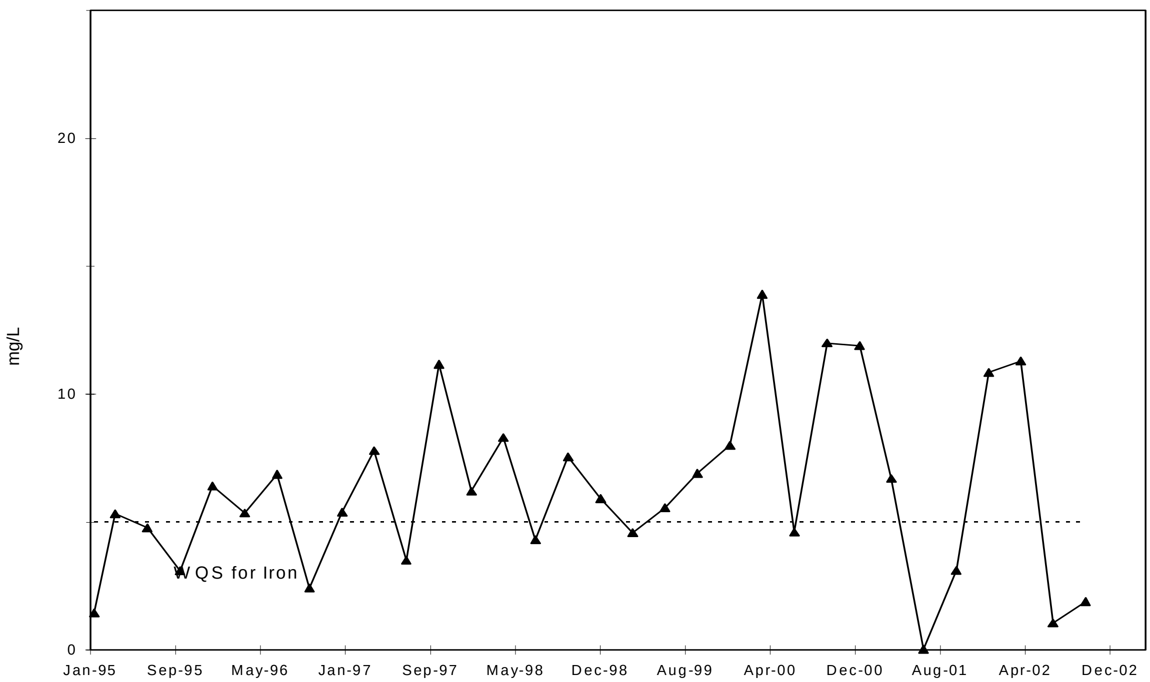


Figure 6.20 Well 800192 Iron Results

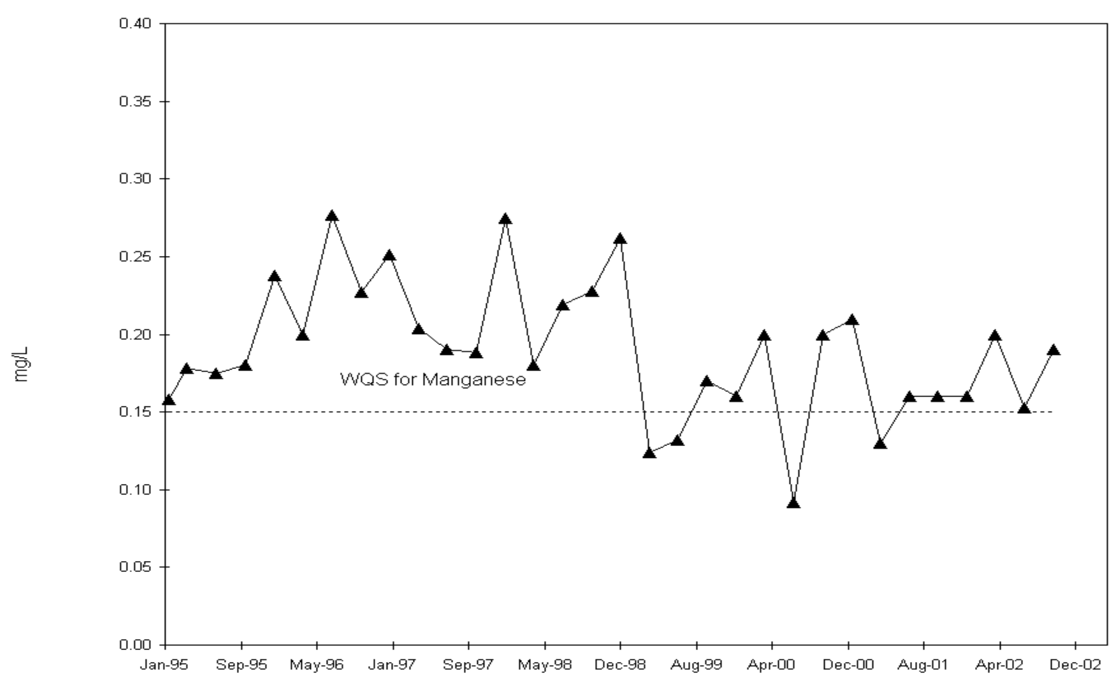


Figure 6.21 Well 800192 Manganese Results

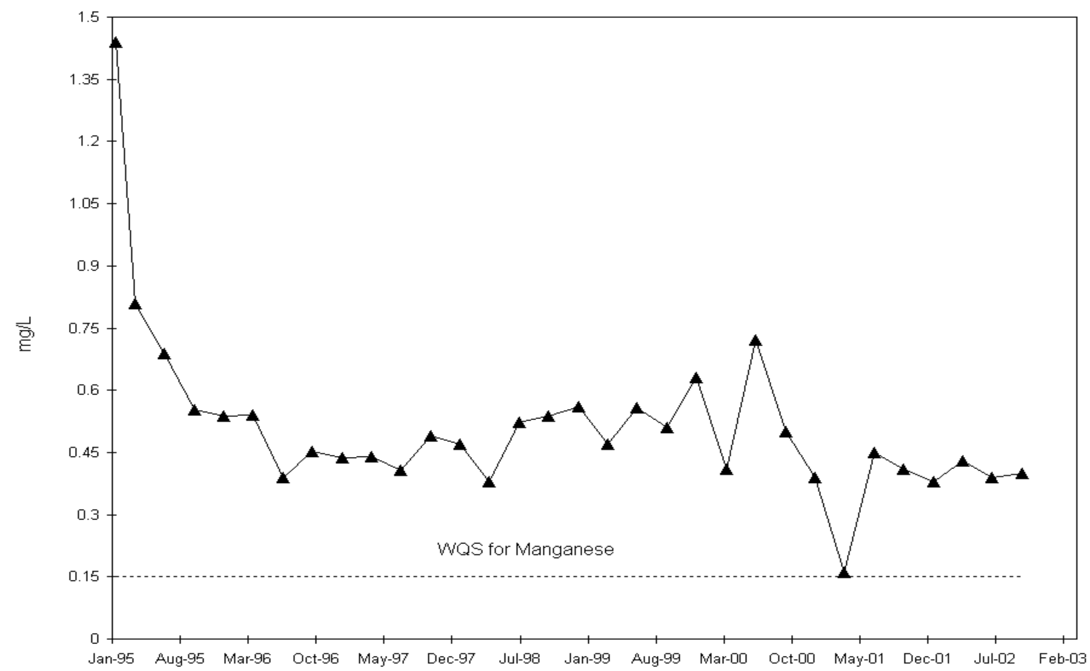


Figure 6.22 Well 800201 Manganese Results

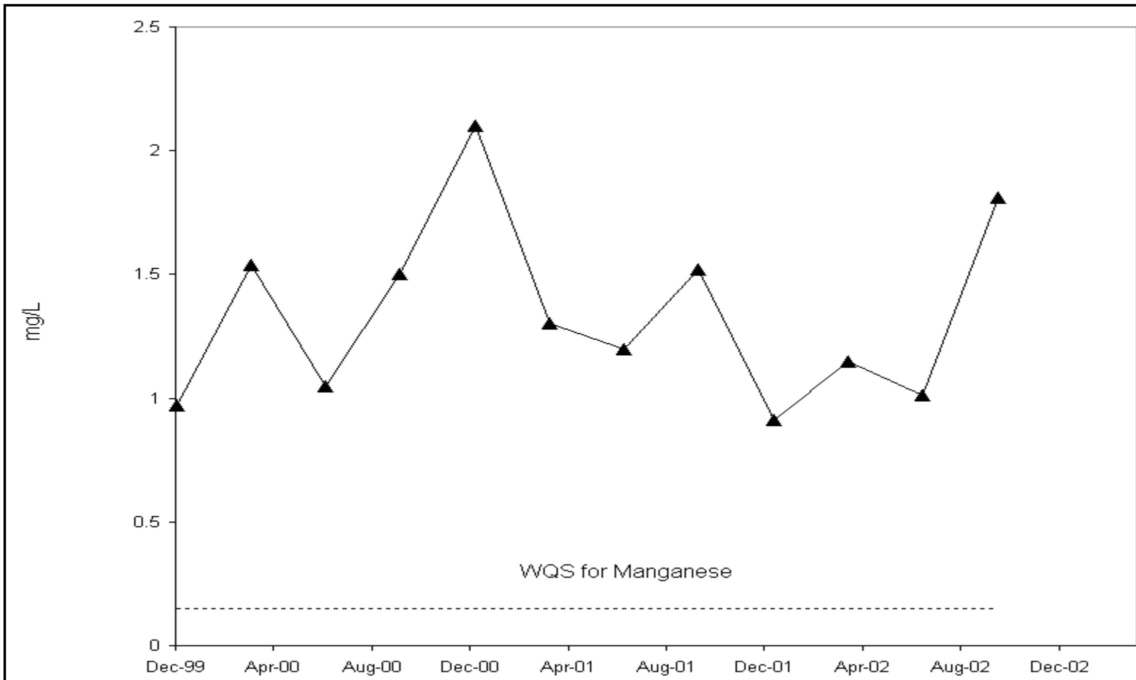


Figure 6.23 Well 800281 Manganese Results

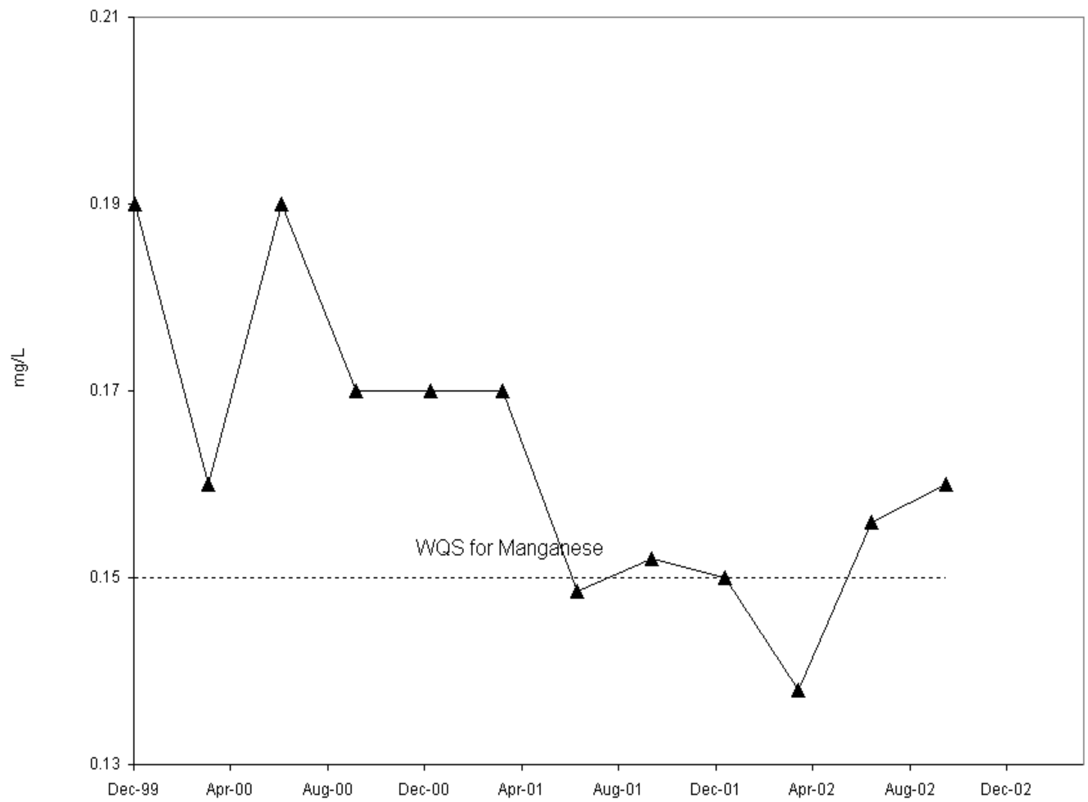


Figure 6.24 Well 800291 Manganese Results

These parameters are measured each quarter. Ammonia, arsenic, cadmium, lead, and mercury were all less than the WQS. As in 2000 and 2001, sulfate exceeded the WQS (400 mg/L) in Wells 800321 and 800381 during two quarters. Sulfate levels ranged from 351 to 1,020 mg/L. As in 2001, chloride exceeded the WQS (200 mg/L) in Wells 800173D and 800191 three and one quarters, respectively, and the chloride levels ranged from 101 to 269 mg/L. TDS exceeded the WQS (1,200 mg/L) in wells 800192, 800321, and 800381, and the TDS levels ranged from 1,092 to 2,680 mg/L.

Iron concentrations exceeded the WQS (5 mg/L) at least once during the year in Wells 800191, 800192, 800202, and 800281. Iron levels in these wells ranged from 0.11 to 11.3 mg/L.

Manganese concentrations exceeded the WQS (0.15 mg/L) during at least one quarter in Wells 800171, 800191, 800192, 800201, 800281, 800291, 800321, and 800381. Manganese levels in these wells ranged from 0.01 to 1.8 mg/L. Manganese appears to be elevated over the entire 800 Area Landfill, and similar concentrations have been measured in monitoring wells across the ANL-E site as well as several miles from the 800 Area Landfill.

Unfiltered Routine Indicator Parameters. These specific parameters include cyanide, phenols (total recoverable), TOC, and TOX and are measured each quarter. With the exception of cyanide, all measured unfiltered routine indicator parameters were less than the appropriate WQS values, where applicable. The cyanide WQS (0.2 mg/L) was exceeded in Well 800173D during the fourth quarter.

Unfiltered Inorganic Parameters. These parameters are measured unfiltered only during the second quarter and include arsenic, barium, boron, cadmium, chloride, chromium, cobalt, copper, cyanide, fluoride, iron, lead, manganese, mercury, nickel, nitrate as nitrogen, selenium, silver, sulfate, and zinc.

As in 2001, sulfate concentrations exceeded the WQS (400 mg/L) only in Well 800321.

Unlike 2001, chromium and nickel concentrations were exceeded in fewer wells. Chromium and nickel concentrations exceeded the WQS (0.1 mg/L) in Well 800281. The nickel WQS was also exceeded in Well 800371.

Iron concentrations exceeded the WQS (5 mg/L) in Wells 800271 (upgradient), 800171, 800181, 800191, 800192, 800201, 800202, 800281, 800291, 800301, 800341, 800351, 800361, 800371, 800381, and 800382. The iron levels ranged from 6.5 to 114.5 mg/L. The iron exceedances are probably due to the requirement that these samples be unfiltered and result from iron in the soil particles suspended in the sample.

Lead concentrations exceeded the WQS (0.0075 mg/L) in Wells 800271 (upgradient), 800171, 800181, 800191, 800201, 800281, 800291, 800301, 800341, 800351, 800371, 800381, and 800382. Lead levels in these wells ranged from 0.0107 to 0.0623 mg/L. These elevated values are also likely to be the result of suspended soil particles in these samples.

Manganese concentrations exceeded the WQS (0.15 mg/L) in Wells 800271 (upgradient), 800171, 800181, 800191, 800192, 800201, 800281, 800291, 800301, 800341, 800351, 800361, 800371, 800381, and 800382. Manganese levels in these wells ranged from 0.06 to 2.2 mg/L. Elevated manganese levels appear to be normal for this area.

Organic Parameters. Each well was sampled quarterly and analyzed for VOCs. VOCs were not detected in any wells in 2002.

Radioactive Constituents. Samples collected from the 800 Area Landfill monitoring wells were also analyzed for hydrogen-3. The results are shown in Tables 6.20 to 6.43. Although the disposal of radioactive materials was prohibited in the sanitary landfill, concentrations of hydrogen-3 were detected only one quarter in Wells 800173D, 800291, 800301, 800331, and 800341 and detected four quarters in well 800281. These wells are located east and southeast of the landfill.

Hydrogen-3 has been consistently noted in Well 800281. Wells 800291 (188 pCi/L) and 800331 (137 pCi/L) were first monitored during 1999, and hydrogen-3 was first detected in these wells in 2001, albeit at levels near detection (100 pCi/L). The presence of hydrogen-3 only during the first quarter in Wells 800331 (137 pCi/L) and 800341 (108 pCi/L) is suspect since the trip blank sample for the first quarter contained hydrogen-3 at 109 pCi/L and its presence in these two wells is probably due to laboratory error. Well 800301 (121 pCi/L) was also first monitored during 1999 and this is the first time hydrogen-3 has been detected at a level near detection and only during the second quarter. This is also the first time hydrogen-3 was detected in deep Well 800173D (396 pCi/L) only during the fourth quarter.

Hydrogen-3 was noted only one quarter in Wells 800191, 800361, and 800371, and four quarters in Well 800192. These wells are located south and at the southwest corner of the landfill area. Hydrogen-3 has been consistently noted in Well 800192. The presence of hydrogen-3 in Well 800191 (108 pCi/L) only during the first quarter is suspect since the trip blank sample for the first quarter contained hydrogen-3 at 109 pCi/L. The levels of hydrogen-3 in Wells 800361 and 800371 were near detection. Only the replicate sample for Well 800361 contained hydrogen-3 and its presence may therefore be due to sampling or laboratory error.

As previously mentioned, the general groundwater flow direction in the shallow glacial drift is to the southeast with a minor component to the west. Seasonal variations are known to exist as evidenced by the inconsistent presence of water in Well 800321. The wells in the southwest corner of the landfill area are adjacent to a stream that may be influencing subsurface water flow on the western side of the landfill area. For those wells with measurable levels of hydrogen-3, the samples were also analyzed for gamma-ray–emitting radionuclides. All results were below the detection limit.

6.4. CP-5 Reactor Area

The CP-5 reactor was an inactive research reactor located in Building 330 (see Figure 1.1). The CP-5 5-MW research reactor was used from 1954 until operations ceased in 1979. In addition to the reactor vessel, the CP-5 complex contained several large cooling towers and an outdoor equipment yard for storing equipment and supplies. The reactor and associated yard area have been decommissioned. A single exploratory monitoring well was installed in 1989 in the yard immediately behind the reactor building, just outside the reactor fuel storage area of the complex. Two new wells were installed as part of a full characterization study of this site, which took place during 1993. The three wells have been sampled quarterly since 1995 and analyzed for radionuclides, metals, VOCs, SVOCs, pesticides, herbicides, and PCBs. A deep well was installed during June 1997 to determine whether there had been any vertical migration of hydrogen-3 to the dolomite from the CP-5 reactor. Table 6.44 characterizes all wells in this area (see Figure 6.25 for locations). The results are shown in Tables 6.45 to 6.48 and are similar to those noted in previous years.

TABLE 6.44

Groundwater Monitoring Wells: 330 Area/CP-5 Reactor

ID Number	Well Depth (m bgs)	Ground Elevation (m AMSL)	Monitoring Zone (m AMSL)	Well Type[a]	Date Drilled
330011	6.1	227.10	224.2–221.1	0.05/PVC	8/89
330021	5.8	227.75	226.3–221.7	0.05/SS	9/93
330031	5.2	227.13	225.6–221.0	0.05/SS	9/93
330012D	41.5	227.13	191.7–185.6	0.05/SS	6/97

[a] Inner diameter (m)/well material (PVC = polyvinyl chloride, SS = stainless steel).

Analysis of data from the existing wells, conducted as part of the RCRA Corrective Action program, indicated the presence of elevated levels of metals. It was concluded that the existing wells were not situated properly and were not installed in a manner suitable to delineate the nature of the groundwater in the CP-5 yard vicinity. To improve the monitoring well network, the existing monitoring network will be expanded in 2003 by adding new wells and abandoning Wells 330021 and 330031 and replacing them with new wells. Abandonment is necessary because these two wells are screened along essentially their entire lengths. The replacement wells will have a shorter screen targeting saturated zones within the drift.

The purpose of the new well installations is to augment the monitoring well network so that data collection from the combined old and new wells will allow determination of groundwater flow directions within the drift and determination of the extent of potential metals contamination.

Well 330011 is installed in a relatively porous, saturated region of soil and fill and as a result, recharges quickly. Purging the well by removing several well volumes of water does not lower the water level appreciably. The water has a higher conductivity and temperature than similar wells at other locations. The manganese WQS (0.15 mg/L) was exceeded three quarters, with levels ranging from 0.10 to 0.58 mg/L. Low levels of barium were noted each quarter; all levels were well below the WQS of 2 mg/L. As in past years, barium was detected each quarter in Well 330021; all levels were considerably below the appropriate WQS. Iron was detected two quarters in Well 330021 at levels well below the WQS (5 mg/L).

Low levels of manganese were noted each quarter in Well 330031. As in 2001, no exceedances of the manganese WQS were noted. Manganese levels ranged from 0.07 to 0.12 mg/L. As in previous years, nickel exceeded the WQS (0.10 mg/L) each quarter in Well 330031. Nickel

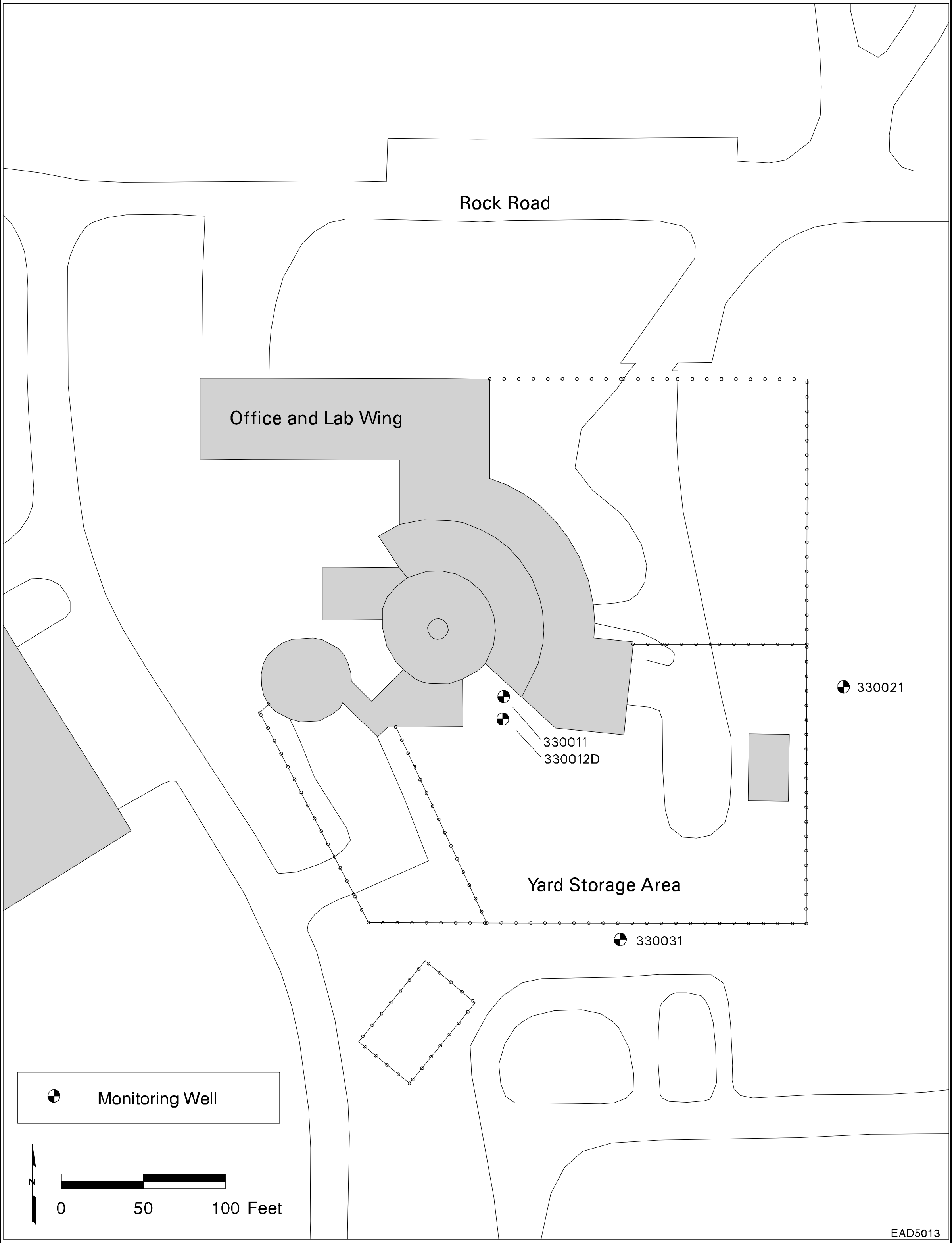


Figure 6.25 Active Monitoring Wells in the CP-5 Reactor Area

TABLE 6.45

Groundwater Monitoring Results, 300 Area Well 330011, 2002

		Date of Sampling			
Parameter	Unit	02/07/02	05/09/02	08/12/02	11/04/02
Water elevation[a]	m	224.54	225.00	224.03	222.99
Temperature	°C	12.9	12.3	16.0	16.3
pH	pH	6.75	6.93	6.84	6.98
Redox	mV	22	3	-9	5
Conductivity	µmhos/cm	1,060	1,115	1,045	1,247
Chloride[b]	mg/L	112	131	77	80
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0514	0.0510	0.0447	0.0619
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	**0.3624**[c]	0.1034	**0.4848**	**0.5793**
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	1,031	2,256	843	1,205
Strontium-90	pCi/L	0.44	0.48	0.51	0.62
Dichlorofluoromethane	µg/L	2	1	2	3

[a] Well point elevation = 221.00 m (MSL); ground surface elevation = 227.10 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.46

Groundwater Monitoring Results, 300 Area Well 330021, 2002

		Date of Sampling			
Parameter	Unit	02/07/02	05/09/02	08/12/02	11/04/02
Water elevation[a]	m	225.88	226.62	225.19	224.55
Temperature	°C	9.5	8.9	13.1	12.9
pH	pH	7.02	7.35	7.04	7.31
Redox	mV	5	-19	-20	-14
Conductivity	μmhos/cm	705	692	770	779
Chloride[b]	mg/L	7	4	6	7
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0249	0.0280	0.0260	0.0291
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.3213	0.2214	< 0.0200	< 0.0200
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	< 0.0100	0.0103	< 0.0100	0.0105
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	182	119	114	155
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25

[a] Well point elevation = 221.95 m (MSL); ground surface elevation = 227.75 m (MSL); casing material = stainless steel.

[b] Filtered sample.

TABLE 6.47

Groundwater Monitoring Results, 300 Area Well 330031, 2002

Parameter	Unit	Date of Sampling 02/07/02	05/09/02	08/12/02	11/04/02	11/04/02
Water elevation[a]	m	226.37	226.72	224.82	223.87	223.87
Temperature	°C	9.9	9.8	13.3	13.1	13.1
pH	pH	7.06	7.03	6.83	7.14	7.14
Redox	mV	4	0	-6	-4	-4
Conductivity	μmhos/cm	1,563	1,350	1,717	1,601	1,601
Chloride[b]	mg/L	197	152	167	110	111
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0375	0.0348	0.0389	0.0364	0.0380
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.0658	0.0710	< 0.02	< 0.02	0.0311
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0735	0.1019	0.1279	0.0807	0.1222
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	**0.7432**[c]	**0.5405**	**0.2767**	**0.2414**	**0.2857**
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	0.008	0.011	0.010
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0	-[d]
Hydrogen-3	pCi/L	156	144	258	395	-
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25	-

[a] Well point elevation = 221.95 m (MSL); ground surface elevation = 227.13 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

[d] A hyphen indicates that no samples were collected.

TABLE 6.48

Groundwater Monitoring Results, 300 Area Well 330012D, 2002

Parameter	Unit	Date of Sampling			
		02/07/02	05/09/02	08/12/02	11/04/02
Water elevation[a]	m	190.39	190.55	190.54	190.41
Temperature	°C	11.9	13.3	14.9	13.4
pH	pH	6.88	7.05	6.96	7.11
Redox	mV	15	-4	-14	-2
Conductivity	μmhos/cm	1,057	984	1,100	1,062
Chloride[b]	mg/L	49	31	38	19
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0654	0.0630	0.0630	0.0638
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.2999	0.5863	0.2288	0.4912
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0299	0.0301	0.0360	0.0348
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	498	< 100	< 100	120
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25

[a] Well point elevation = 185.65 m (MSL); ground surface elevation = 227.13 m (MSL); casing material = stainless steel.

[b] Filtered sample.

levels ranged from 0.24 to 0.74 mg/L. The source of nickel is unknown. Barium and iron were detected at levels well below the WQS each quarter.

Barium, iron, and manganese were detected each quarter in Well 330012D; all levels were considerably below the appropriate WQS.

As in past years, Well 330011 contained low concentrations of dichlorofluoromethane; concentrations ranged from 1 to 3 μg/L.

In general, radionuclide levels were similar to those noted in 2000 and 2001 (see Figures 6.26 and 6.27). Hydrogen-3 was detected each quarter in Wells 330011, 330021, and 330031. The levels of hydrogen-3 ranged from 114 to 2,256 pCi/L. Hydrogen-3 was noted two quarters in Well 330012D. These levels are well below the WQS (20,000 pCi/L). Similar to past years, strontium-90 was detected each quarter in Well 330011. The levels ranged from 0.44 to 0.62 pCi/L. These levels are well below the WQS (8 pCi/L).

The CP-5 was a heavy-water–moderated reactor. During its operational life, several incidents occurred that released small amounts of this heavy water containing high concentrations of hydrogen-3 to the environment. In addition, the normal operation released significant amounts of water vapor containing hydrogen-3 from the main ventilation system that may have condensed and fallen to the ground in the form of precipitation. These activities are believed to be responsible for the residual amounts of hydrogen-3 now found in the groundwater. The source of the strontium-90 is not known.

6.5. Monitoring of the Seeps South of the 300 Area

In spring 1996, during the RCRA Facility Investigation of the 317/319 Area, a series of groundwater seeps was discovered in a network of steeply eroded ravines in the Waterfall Glen Forest Preserve south and southeast of the 317 and 319 Areas. Three seeps (SP01, SP02, and SP04) are located about 200 m (600 ft) south of the 319 Area; two other seeps (SP03 and SP05) are located about 360 m (1,200 ft) south of the 317 Area and are considered clean background seeps. The locations are shown in Figure 6.28. The seeps are in ravines that are located in a pristine, heavily wooded section of the forest preserve. The ravines carry storm water drainage from the 317 and 319 Areas. Storm water flow has eroded the soil deep enough to expose a shallow sandy layer containing groundwater. Water emanating from the exposed sandy layer flows to the nearby ravine, where it forms a small rivulet in the bottom of the ravine. Approximately 30 m (100 ft) downstream of the seep area, the affected water from the seeps is no longer visible because it drains back into the soil in the bed of the ravine. During extended dry weather conditions, the flow disappears completely. The IEPA has designated this area as AOC-G — Off-Site Groundwater Seeps.

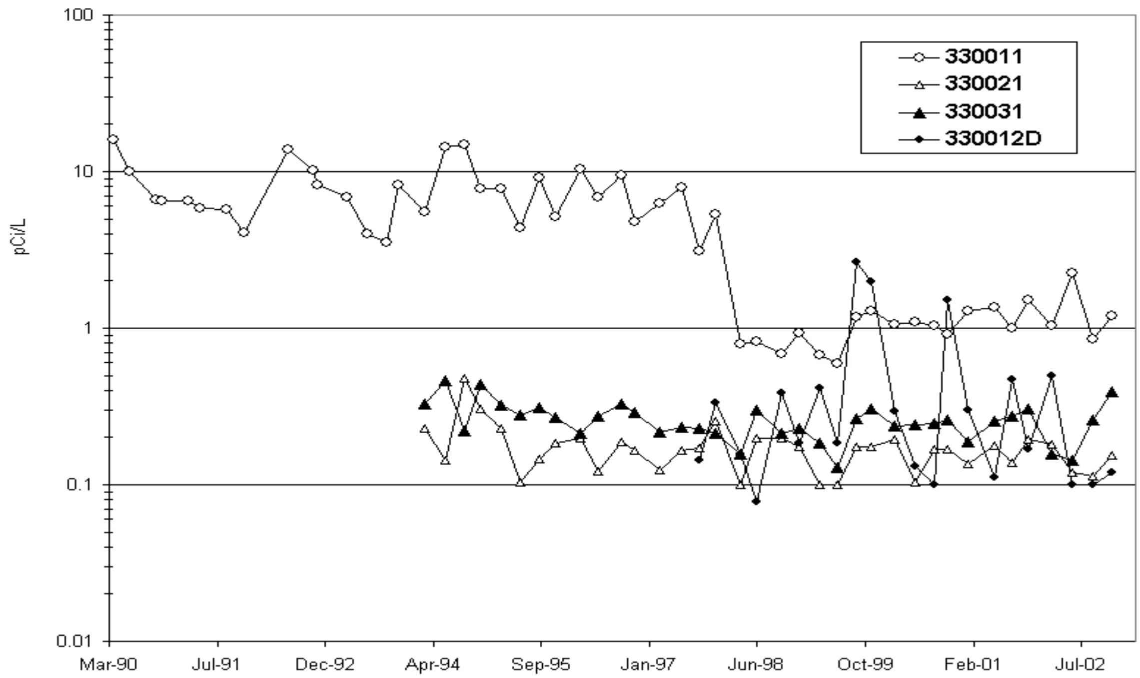


Figure 6.26 Hydrogen-3 Results in the CP-5 Monitoring Wells

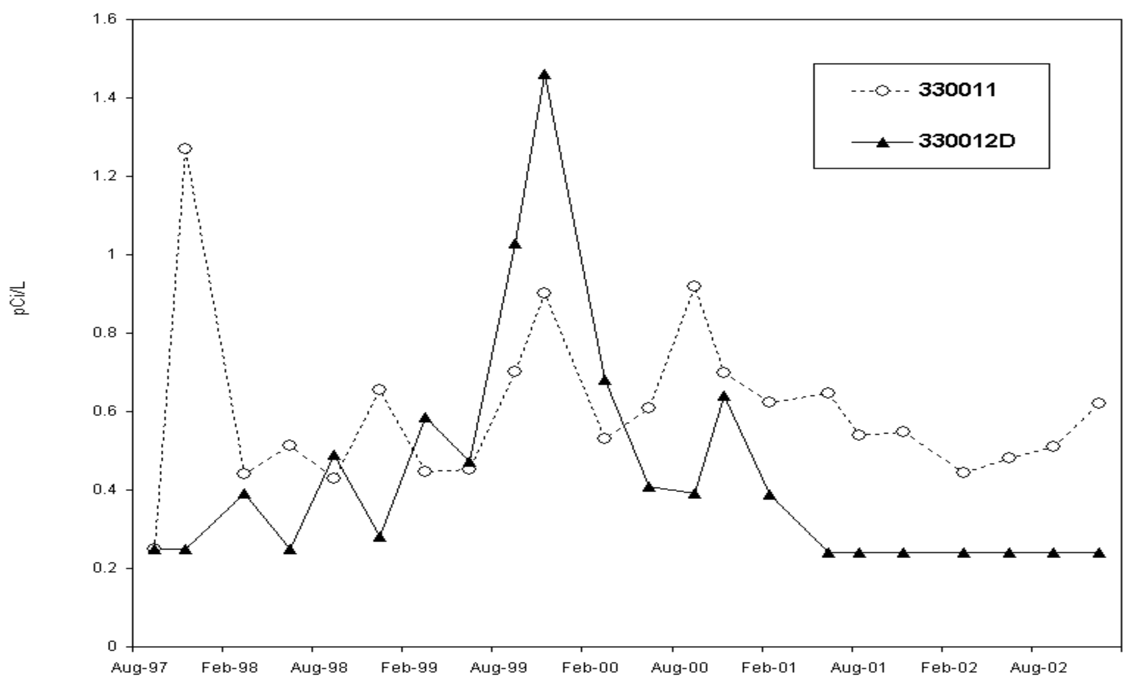


Figure 6.27 Strontium-90 Results in the CP-5 Monitoring Wells

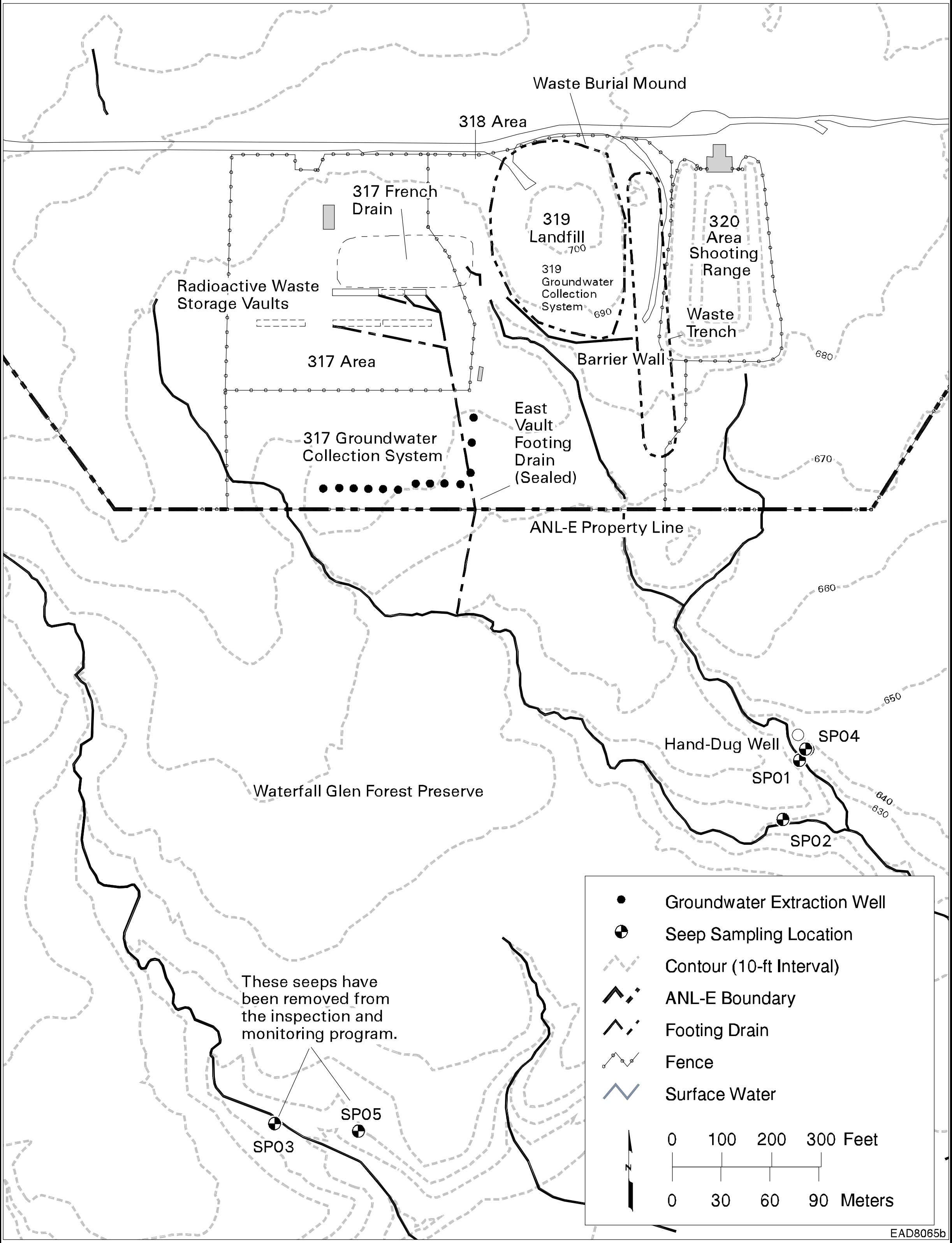


Figure 6.28 Seep Locations South of the 317/319 Area

Initial samples were collected and analyzed for metals, VOCs, and selected radionuclides. Two groundwater seeps contained measurable levels of three VOCs — carbon tetrachloride, chloroform, and tetrachloroethene. Carbon tetrachloride and tetrachloroethene concentrations exceeded the Class I Groundwater Quality Standards. The other three seeps did not contain any quantifiable VOCs. Three of the five seeps, including the two containing the VOCs, were found to contain hydrogen-3 in measurable concentrations. Since the initial samples were collected, monthly samples were obtained through the end of 1997, and quarterly samples collected to the end of 1998. These results are summarized in the 1998 SER.[15]

During 2002, Seeps SP01, SP02, and SP04 were sampled quarterly for VOCs and hydrogen-3. VOCs were noted in each seep each quarter except for SP02 during the second quarter. As in previous years, Seep SP04 showed the highest levels of all three VOCs (carbon tetrachloride, chloroform, and tetrachloroethene) each quarter. The data are presented in Table 6.49. The hydrogen-3 and VOC results are consistent with past data, which indicates a gradual decline in concentrations, with the exception of chloroform in SP04, since measurements began in 1996 (see Figures 6.29 and 6.30).

Monitoring was also conducted quarterly at an artesian well located about 2,000 m (6,000 ft) southwest of the 317 Area (location 3E in Figure 1.1). All hydrogen-3 concentrations were less than the detection limit of 100 pCi/L. This finding suggests that any subsurface contaminant movement has not extended to this location and indicates a western limit to movement.

TABLE 6.49

Contaminant Concentrations in Seep Water, 2000 to 2002

Site	Date Collected	Hydrogen-3 (pCi/L)	Carbon Tetrachloride (µg/L)	Chloroform (µg/L)	Tetrachloroethene (µg/L)
SP01	03/21/00	706	5	2	<1
	06/07/00	1,425	**6**[a]	2	<1
	08/21/00	1,178	**8**	2	<1
	11/03/00	1,120	**7**	2	<1
	01/31/01	640	5	1	<1
	05/15/01	633	**7**	1	<1
	09/07/01	555	4	1	<1
	11/02/01	645	**6**	2	<1
	01/28/02	614	2	<1	<1
	04/18/02	383	2	1	<1
	07/30/02	242	4	2	<1
	11/13/02	250	**7**	4	<1
SP02	03/21/00	1,998	1	<1	<1
	06/07/00	1,124	1	<1	<1
	08/21/00	625	3	<1	<1
	11/03/00	1,348	2	<1	<1
	01/031/01	1,383	2	<1	<1
	05/15/01	340	2	<1	<1
	09/07/01	619	2	<1	<1
	11/02/01	626	2	<1	<1
	01/28/02	572	**7**	2	<1
	04/18/02	274	<1	<1	<1
	07/30/02	188	1	<1	<1
	11/13/02	326	1	<1	<1
SP04	03/21/00	Dry	Dry	Dry	Dry
	06/07/00	1,043	**179**	18	7
	08/21/00	435	**301**	28	9
	11/03/00	323	**194**	23	6
	01/31/01	418	**221**	22	6
	05/15/01	124	**208**	25	7
	09/07/01	117	**145**	54	7
	11/02/01	183	**148**	23	6
	01/28/02	409	**152**	20	5
	04/18/02	< 100	**143**	20	7
	07/30/02	< 100	**180**	26	6
	11/13/02	116	**118**	43	6

[a] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

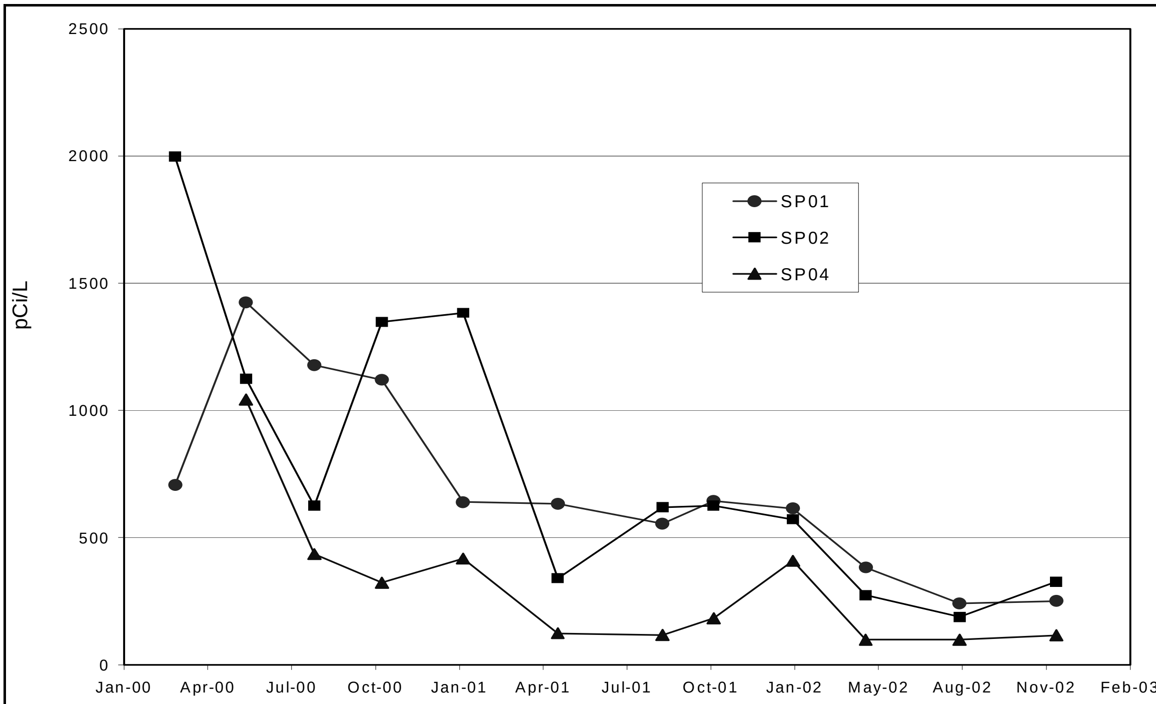


Figure 6.29 Hydrogen-3 Concentrations in Seep Water, 2000 to 2002

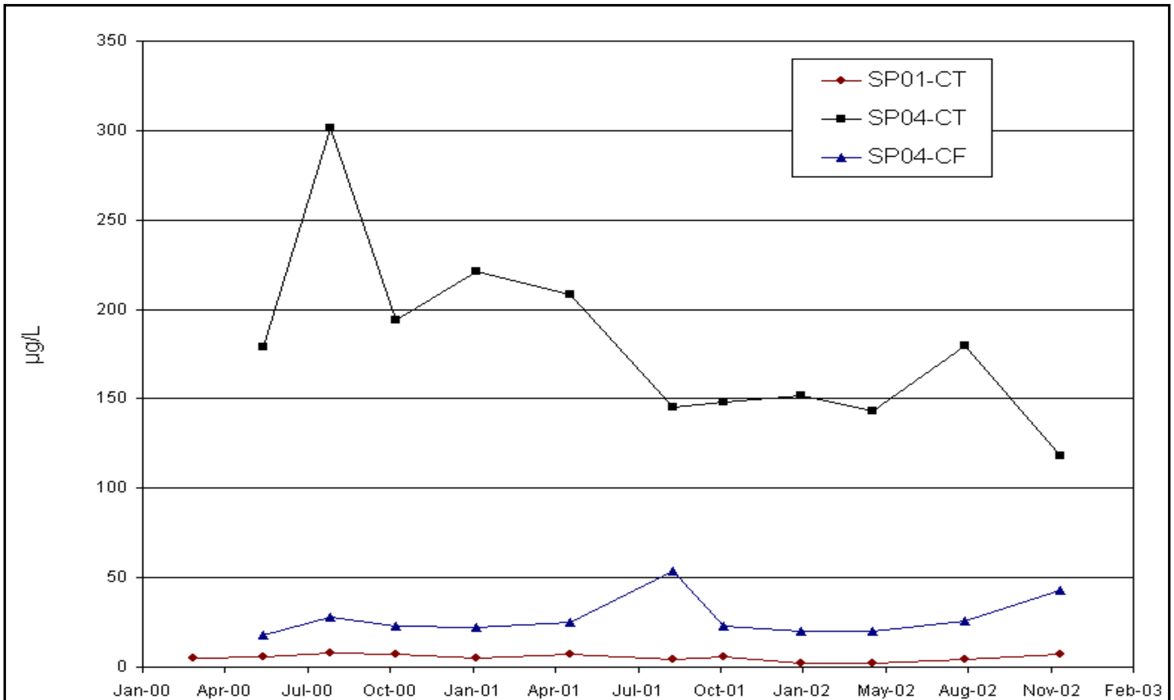
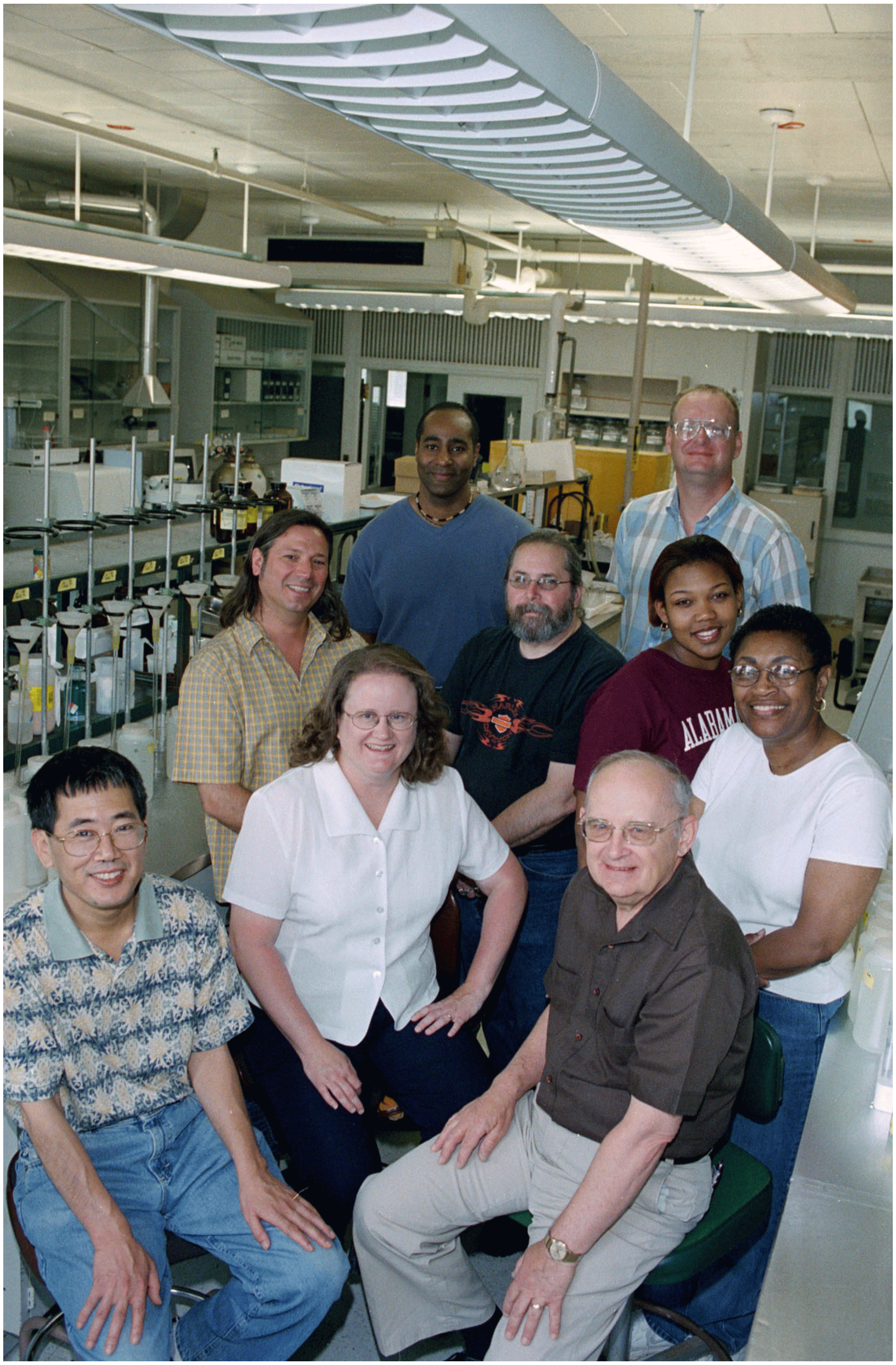


Figure 6.30 Carbon Tetrachloride and Chloroform Concentrations in Seep Water, 2000 to 2002

7. QUALITY ASSURANCE



QA plans exist for both radiological and nonradiological analyses; these QA documents were prepared in accordance with DOE Order 414.1[30] and discuss who is responsible for QA and for auditing analyses. Both documents are supplemented by operating manuals.

7.1. Sample Collection

Many factors enter into an overall QA program other than the analytical quality control. Representative sampling is of prime importance. Appropriate sampling protocols are followed for each type of sampling being conducted. Water samples are pretreated in a manner designed to maintain the integrity of the analytical constituent. For example, samples for trace radionuclide analyses are acidified immediately after collection to prevent hydrolytic loss of metal ions and are filtered to reduce leaching from suspended solids.

The monitoring wells are sampled using the protocols listed in the *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*.[29] The volume of water in the casing is determined by measuring the water depth from the surface and the depth to the bottom of the well. This latter measurement also determines whether siltation has occurred that might restrict water movement in the screened area. For those wells in the glacial drift that do not recharge rapidly, the well is emptied, and the volume removed is compared with the calculated volume. In most cases, these volumes are nearly identical. The well is then sampled by bailing with a Teflon bailer. If samples for parameters such as priority pollutants are collected, field parameters for these samples (pH, specific conductance, redox potential, and temperature) are measured per well volume while purging. For samples in the porous, saturated zone, which recharges rapidly, three well volumes are purged by using submersible pumps. If field parameters are measured, samples are collected as soon as these readings stabilize. All samples are placed in precleaned bottles, labeled, and preserved. All field measurement and sampling equipment is cleaned by field rinsing with Type II deionized water. The samples are transferred to the analytical laboratory via a computer floppy disk that generates a one-page list of all samples. This list acts as the chain of custody transfer document.

7.2. Radiochemical Analysis and Radioactivity Measurements

The documentation for radiological analyses is contained in the ESH-AC procedure manual. All nuclear instrumentation is calibrated with standard sources obtained from or traceable to the National Institute of Standards and Technology (NIST). The equipment is checked daily with secondary counting standards to ensure proper operation. Samples are periodically analyzed in duplicate or with the addition of known amounts of a radionuclide to check precision and accuracy. When a nuclide is not detected, the result is given as “less than” (<) the detection limit by the analytical method used. The detection limits are chosen so that the measurement uncertainty at the 95% confidence level is equal to the measured value. The air and water detection limits for all radionuclides for which measurements were made in 2002 are given in Table 7.1. The relative error in a result decreases with increasing concentration. At a concentration equal to twice the detection limit, the error is approximately 50% of the measured value; at 10 times the detection limit, the error is approximately 10% at the 95% confidence level.

Average values are accompanied by a plus-or-minus (±) limit value. Unless otherwise stated, this value is the standard error at the 95% confidence level calculated from the standard deviation of the average. The ± limit value is a measure of the range in the concentrations encountered at that location; it does not represent the conventional uncertainty in the average of repeated measurements on the same or identical samples. Because many of the variations observed in environmental radioactivity are not random but occur for specific reasons (e.g., seasonal variations), samples collected from the same location at different times are not replicates. The more random the variation in activity at a particular location, the closer the confidence limits will represent the actual distribution of values at that location. The averages and confidence limits should be interpreted with this in mind. When a ± value accompanies an individual result in this report, it represents the statistical counting error at the 95% confidence level.

TABLE 7.1

Air and Water Detection Limits

Nuclide or Activity	Air (fCi/m^3)	Water (pCi/L)
Americium-241	-[a]	0.001
Beryllium-7	5	-
Californium-249	-	0.001
Californium-252	-	0.001
Cesium-137	0.1	2
Curium-242	-	0.001
Curium-244	-	0.001
Hydrogen-3	-	100
Lead-210	1	-
Neptunium-237	-	0.001
Plutonium-238	0.0001	0.001
Plutonium-239	0.0001	0.001
Radium-226	-	0.02
Radium-228	-	0.02
Strontium-89	0.1	2
Strontium-90	0.01	0.25
Thorium-228	0.001	-
Thorium-230	0.001	-
Thorium-232	0.001	-
Uranium-234	0.001	0.01
Uranium-235	0.001	0.01
Uranium-238	0.001	0.01
Uranium - natural	0.02	0.2
Alpha	0.2	0.2
Beta	0.5	1

[a] A hyphen indicates that a value is not required.

ANL-E continues to participate in the DOE Environmental Measurements Laboratory Quality Assurance Program (DOE-EML-QAP), which consists of semiannual distribution of three different sample matrices containing various combinations of radionuclides that are analyzed. Table 7.2 summarizes the results for 2002. In the table, the EML value, which is the result of duplicate determinations by that laboratory, is compared with the average value obtained in the ANL-E laboratory. Information that will assist in judging the quality of the results includes

TABLE 7.2

Summary of DOE-EML-QAP Samples, 2002

Matrix	Constituent	Date	Unit	EML	ANL-E	Ratio	Comments
Air filter	Manganese-54	March	Bq/filter	38.53	38.00	0.99	Acceptable
		Sept.		52.20	52.50	1.01	Acceptable
	Cobalt-60	March		30.52	31.50	1.03	Acceptable
		Sept.		23.00	23.90	1.04	Acceptable
	Strontium-90	March		4.83	4.25	0.88	Acceptable
		Sept.		5.56	5.00	0.90	Acceptable
	Cesium-137	March		28.23	29.10	1.03	Acceptable
		Sept.		32.50	33.90	1.04	Acceptable
	Uranium-234	March		0.297	0.290	0.98	Acceptable
		Sept.		0.228	0.210	0.92	Acceptable
	Uranium-238	March		0.298	0.300	1.01	Acceptable
		Sept.		0.230	0.200	0.87	Warning
	Plutonium-238	March		0.057	0.070	1.22	Warning
		Sept.		0.119	0.100	0.84	Warning
	Plutonium-239	March		0.187	0.180	0.96	Acceptable
		Sept.		0.209	0.200	0.97	Acceptable
	Americium-241	March		0.088	0.090	1.02	Acceptable
		Sept.		0.191	0.200	1.05	Acceptable
Soil	Potassium-40	March	Bq/kg	621.7	648.0	1.04	Acceptable
		Sept.		637.7	665.0	1.04	Acceptable
	Strontium-90	March		53.8	46.9	0.81	Acceptable
		Sept.		41.2	41.1	1.00	Acceptable
	Cesium-137	March		1326.7	1396.0	1.01	Acceptable
		Sept.		829.3	880.0	1.06	Acceptable
	Uranium-234	March		93.9	140.0	1.49	Not Acceptable
		Sept.		42.3	40.8	0.96	Acceptable
	Uranium-238	March		96.8	137.0	1.42	Not Acceptable
		Sept.		44.9	46.3	1.03	Acceptable
	Plutonium-239	March		19.10	20.50	1.07	Acceptable
		Sept.		12.90	13.40	1.04	Acceptable
	Americium-241	March		10.93	13.10	1.20	Acceptable
		Sept.		6.77	7.20	1.06	Acceptable

TABLE 7.2 (Cont.)

Matrix	Constituent	Date	Unit	EML	ANL-E	Ratio	Comments
Water	Hydrogen-3	March	Bq/L	283.7	289.0	1.02	Acceptable
		Sept.		227.3	240.0	1.06	Acceptable
	Cobalt-60	March		347.3	345.0	0.99	Acceptable
		Sept.		268.7	271.0	1.01	Acceptable
	Strontium-90	March		7.58	6.78	0.90	Acceptable
		Sept.		8.69	8.40	0.97	Acceptable
	Cesium-134	March		3.36	2.35	0.70	Not Acceptable
		Sept.		60.2	65.7	1.09	Acceptable
	Cesium-137	March		56.1	54.8	0.98	Acceptable
		Sept.		81.4	80.7	0.99	Acceptable
	Uranium-234	March		1.40	1.36	0.97	Acceptable
		Sept.		3.32	3.20	0.96	Acceptable
	Uranium-238	March		1.38	1.32	0.96	Acceptable
		Sept.		3.37	3.20	0.95	Acceptable
	Plutonium-238	March		0.490	0.500	1.02	Acceptable
		Sept.		4.33	4.00	0.92	Acceptable
	Plutonium-239	March		4.22	4.16	0.99	Acceptable
		Sept.		2.07	2.10	1.01	Acceptable
	Americium-241	March		1.47	1.50	1.02	Acceptable
		Sept.		3.04	2.80	0.92	Acceptable

the fact that typical uncertainties for ANL-E's analyses are 2 to 50%, and that the uncertainties in the EML results are 1 to 30% (depending on the nuclide and the amount present). For most analyses for which the differences are large (> 20%), the concentrations were quite low and the differences were within the measurement uncertainties.

Overall, the ANL-E performance in the EML intercomparison studies on the three matrices resulted in over 88% (46 out of 52) of the analysis being in the DOE-EML-QAP acceptable range. Three samples fell within the warning category, while three results were not acceptable. The ANL-E performance on these samples indicated that, for the most part, the reported results are accurate.

7.3. Chemical Analysis

The documentation for nonradiological analyses is contained in the ESH-AC Procedure Manual. All samples for NPDES and groundwater are collected and analyzed in accordance with EPA regulations found in 40 CFR Part 136,[24] EPA-600/4-84-017,[31] and SW-846.[6]

Standard reference materials traceable to the NIST exist for most inorganic analyses (see Table 7.3) and are replaced annually. Detection limits are determined with techniques listed in 40 CFR Part 136[24] and are given in Table 7.4. In general, the detection limit is the measure of the variability of a standard material measurement at 5 to 10 times the instrument detection limit as measured over an extended time period. Recovery of inorganic metals, as determined by "spiking" unknown solutions, must be within the range of 75 to 125%. The precision, as determined by analysis of duplicate samples, must be within 20%. These measurements must be taken for at least 10% of the samples. Comparison samples for organic constituents were formerly available from the EPA; they are now commercially available under the Cooperative Research and Development Agreement that exists between the EPA and commercial laboratories. In addition, standards are available that are certified by the American Association for Laboratory Accreditation, under a Memorandum of Understanding with the EPA. Many of these standards were used in this work. At least one standard mixture is analyzed each month; Tables 7.5 and 7.6 show the 2002 results for VOCs and SVOCs, respectively. The recoveries listed are those required by the respective methods.

7.4. NPDES Analytical Quality Assurance

ANL-E conducts the majority of the analyses required for inclusion in the DMR. These analyses are conducted in accordance with EPA-approved methods set out in 40 CFR Part 136.[24] To demonstrate the capabilities of the ANL-E laboratory for these analyses, the EPA requires that ANL-E participate in the DMR-QA program. An EPA-accredited provider sends a series of intercomparison samples to ANL-E annually, and the ensuing analytical results are submitted to the provider for review. The proficiency of the laboratory is determined by comparing the analytical results for the submitted samples with the provider values. The ANL-E laboratory has consistently performed very well on these tests. In 2002, all results were acceptable, with the exception of beryllium and total cyanide. A corrective action statement was prepared and forwarded to the EPA provider and the IEPA. The results of these analyses are shown in Table 7.7.

TABLE 7.3

Standard Reference Materials Used for Inorganic Analysis

Constituent	Reference Material[a]
Antimony	VHG-ASBH-100
Arsenic	VHG-AASN-100
Barium	VHG-PBAN-100
Beryllium	VHG-ABEN-100
Boron	VHG-PBW-100
Cadmium	VHG-ACDN-100
Chromium	VHG-ACRH-100
Cobalt	VHG-PCON-100
Copper	VHG-ACUN-100
Iron	VHG-AFEN-100
Lead	VHG-APBN-100
Manganese	VHG-AMNN-100
Mercury	VHG-AHGN-100
Nickel	VHG-ANIN-100
Selenium	VHG-ASEN-100
Silver	VHG-AAGN-100
Thallium	VHG-ATLN-100
Vanadium	VHG-PVN-100
Zinc	VHG-AZNN-100
Sulfate	NIST-SRM 3181
Chloride	LABCHEM LC 13000-7
Fluoride	ORION 940907

[a] VHG = VHG Labs, Inc.; NIST-SRM = National Institute of Standards and Technology - Standard Reference Materials; LABCHEM = Labchem, Inc.; ORION = Orion, Inc.

TABLE 7.4

Detection Limit for Metals Analysis, 2002

	Detection Limit (mg/L)	
Constituent	AA[a]	ICP[b]
Antimony	0.0030	NA[c]
Arsenic	0.0030	0.076
Barium	NA	0.010
Beryllium	0.0002	0.010
Boron	NA	0.016
Cadmium	0.0002	0.015
Chromium	0.015	0.024
Cobalt	NA	0.016
Copper	0.010	0.015
Hexavalent chromium[d]	0.006	NA
Iron	0.040	0.020
Lead	0.0020	0.086
Manganese	0.015	0.010
Mercury	0.0001	NA
Nickel	0.030	0.020
Selenium	0.0030	0.121
Silver	0.0010	NA
Thallium	0.0020	0.082
Vanadium	NA	0.032
Zinc	0.010	0.008

[a] AA = atomic absorption spectroscopy.

[b] ICP = inductively coupled plasma-atomic emission spectroscopy.

[c] NA = not analyzed.

[d] Colorimetric measurement.

TABLE 7.5

Quality Check Sample Results: Volatile Analyses, 2002

Constituent	Recovery[a] (%)	Quality Limit (%)
Benzene	108	73–126
Bromobenzene	98	76–133
Bromodichloromethane	97	50–140
Bromoform	79	57–156
Butylbenzene	107	71–125
sec-Butylbenzene	106	71–145
t-Butylbenzene	104	69–134
Carbon tetrachloride	91	86–118
Chlorobenzene	104	80–137
Chloroform	105	68–120
o-Chlorotoluene	98	81–146
p-Chlorotoluene	96	73–144
1,2-Dibromo-3-chloropropane	86	36–154
Dibromochloromethane	88	68–130
1,2-Dibromoethane	78	75–149
Dibromomethane	99	65–143
1,2-Dichlorobenzene	100	59–174
1,3-Dichlorobenzene	105	84–143
1,4-Dichlorobenzene	106	58–172
1,1-Dichloroethane	105	71–142
1,2-Dichloroethane	100	70–134
1,1-Dichloroethene	95	18–209
cis-1,2-Dichloroethene	108	85–124
trans-1,2-Dichloroethene	100	67–141
1,2-Dichloropropane	101	19–179
1,3-Dichloropropane	103	73–145
1,1-Dichloropropene	103	71–133
Ethyl benzene	100	84–130
Isopropylbenzene	106	70–144
4-Isopropyltoluene	112	72–140
Methylene chloride	112	D–197[b]
n-Propylbenzene	104	78–139
1,1,1,2-Tetrachloroethane	89	88–133
Tetrachloroethene	101	84–132
Toluene	102	81–130
1,1,1-Trichloroethane	93	68–149
1,1,2-Trichloroethane	102	70–133
Trichloroethene	97	91–135
1,2,3-Trichloropropane	99	50–158
1,2,4-Trimethylbenzene	103	80–144
1,3,5-Trimethylbenzene	104	76–142
o-Xylene	99	79–141
p-Xylene	101	74–138

[a] Average of two determinations.

[b] D denotes that the compound was detected.

TABLE 7.6

Quality Check Sample Results:
Semivolatile Analyses, 2002

Constituent	Recovery[a] (%)	Quality Limit (%)
2-Fluorophenol[b]	44.0	21–100
Phenol-d5[b]	79.7	10–94
Phenol	57.2	17–100
2-Chlorophenol	79.8	36–120
1,3-Dichlorobenzene	60.3	33–95
1,4-Dichlorobenzene	104.0	37–106
n-Nitroso-n-Propylamine	71.2	24–198
Nitrobenzene-d5[b]	92.7	35–114
1,2,4-Trichlorobenzene	66.8	57–129
4-Chloro-3-Methylphenol	93.0	41–128
2-Fluorobiphenyl[b]	61.3	43–116
2-Methylnaphthalene	54.2	45–113
Acenaphthene	76.7	47–145
2,4-Dinitrotoluene	105.0	48–127
2,4,6-Tribromophenol[b]	104.0	10–123
Pentachlorophenol	129.0	38–152
Pyrene	95.2	70–100
Terphenyl-d14[b]	88.6	33–141

[a] Average of three determinations.

[b] Required surrogates.

TABLE 7.7

Summary of DMR-QA Intercomparison Samples, 2002

Analyte	Units[a]	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
Antimony	μg/L	364	336	230–407	Acceptable
Arsenic	μg/L	203	205	169–242	Acceptable
Barium	μg/L	509	515	444–588	Acceptable
Beryllium	μg/L	137	117	98.3–132	Not acceptable
Boron	μg/L	349	330	258–426	Acceptable
Cadmium	μg/L	263	279	238–317	Acceptable
Chromium	μg/L	340	335	291–380	Acceptable
Cobalt	μg/L	205	202	176–227	Acceptable
Copper	μg/L	514	529	480–581	Acceptable
Iron	μg/L	754	759	670–859	Acceptable
Lead	μg/L	283	266	228–303	Acceptable
Manganese	μg/L	901	918	825–1020	Acceptable
Mercury	μg/L	7.30	7.57	5.61–9.50	Acceptable
Nickel	μg/L	685	674	607–754	Acceptable
Selenium	μg/L	289	280	219–325	Acceptable
Silver	μg/L	239	220	188–252	Acceptable
Thallium	μg/L	628	685	552–795	Acceptable
Vanadium	μg/L	349	360	322–395	Acceptable
Zinc	μg/L	436	439	387–496	Acceptable
Biochemical oxygen demand	μg/L	37.8	37.2	18.5–55.8	Acceptable
Chemical oxygen demand	mg/L	53.0	59.9	41.7–73.3	Acceptable
Ammonia nitrogen	mg/L	7.63	7.79	6.01–9.50	Acceptable
Total residual chlorine	mg/L	1.46	1.51	1.20–1.82	Acceptable
Total cyanide	mg/L	0.170	0.279	0.188–0.363	Not acceptable
pH	S.U.	5.63	5.6	5.48–5.72	Acceptable
Total phenolics	mg/L	0.086	0.074	0.032–0.115	Acceptable
Total suspended solids	mg/L	40.5	41.1	30.6–43.9	Acceptable
Grease and oil	mg/L	26.3	28.0	17.5–33.2	Acceptable
Fathead minnow acute toxicity	LC_{50}	39.2	44.9	20.0–69.8	Acceptable
Water flea acute toxicity	LC_{50}	9.9	36.4	<6.25–74.5	Acceptable

[a] μg/L = micrograms/liter; mg/L = milligrams/liter; S.U. = standard unit; and LC_{50} = the calculated effluent concentration at which 50% of the test organisms are killed in a specified time period.

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